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U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF FORESTRY—BULLETIN No. 54.
GIFFORD PINCHOT, Forester.

THE LUQUILLO FOREST RESERVE, PORTO RICO.

BY

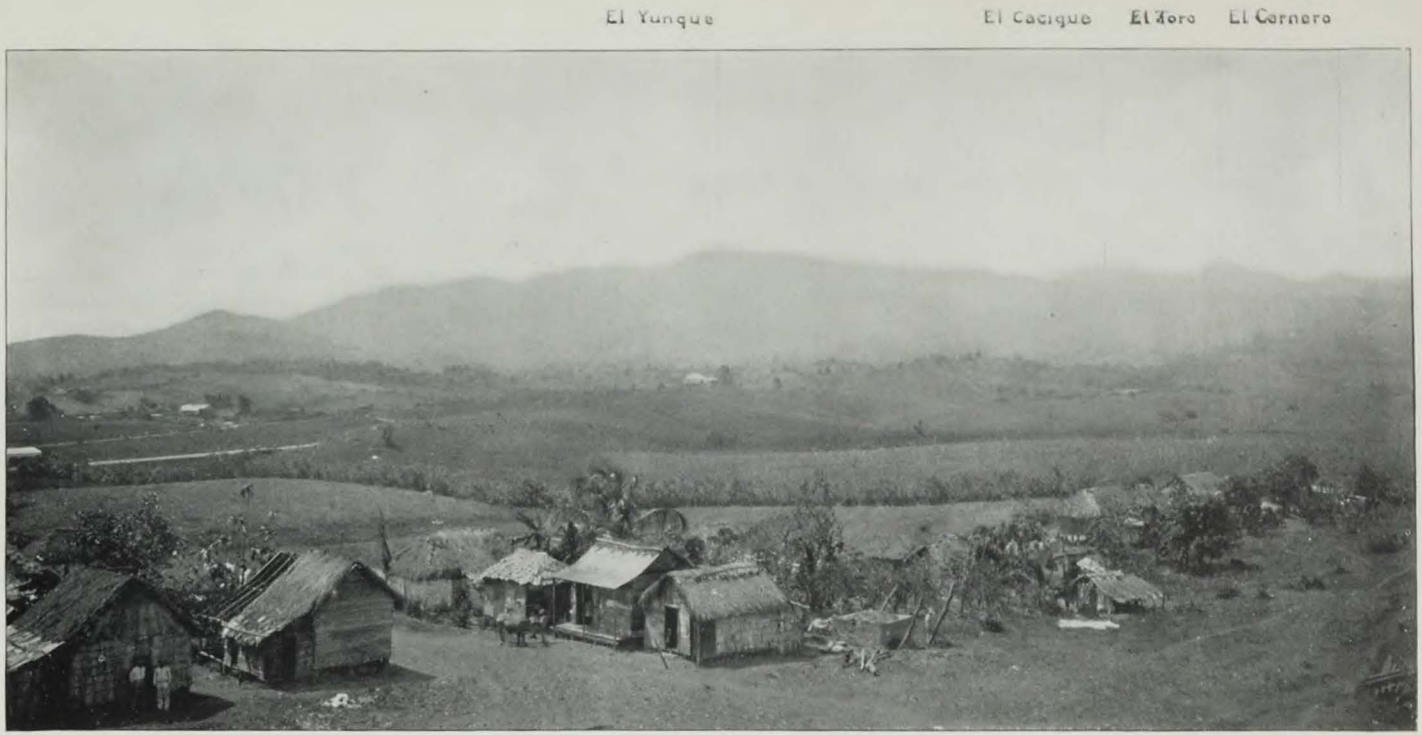
JOHN C. GIFFORD, D. Œc.,
Agent, Bureau of Forestry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1905.

Wm. R. Kreutzer

Forest Service

Colo.



THE MOUNTAINS OF THE LUQUILLO FOREST RESERVE VIEWED FROM THE TOWN OF RIO GRANDE, ABOUT FIVE MILES TO THE NORTH.

The large mountain in the center of the picture is El Yunque.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY,
Washington, D. C., June 29, 1904.

SIR: I have the honor to transmit herewith a report entitled "The Luquillo Forest Reserve, Porto Rico," by Dr. John C. Gifford, Agent in the Bureau of Forestry, and to recommend its publication as Bulletin No. 54 of the Bureau of Forestry.

The eight plates accompanying the text are necessary for its proper illustration.

Very respectfully,

GIFFORD PINCHOT,
Forester.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE LUQUILLO FOREST RESERVE, PORTO RICO.

GENERAL DESCRIPTION.

LOCATION AND TOPOGRAPHY.

The Luquillo Forest Reserve, Porto Rico, was created by the following Presidential proclamation:

Whereas, it is provided by section one of the act of Congress, approved July first, nineteen hundred and two, entitled "An act authorizing the President to reserve public lands and buildings in the island of Porto Rico for public uses, and granting other public lands and buildings to the government of Porto Rico, and for other purposes," "That the President be, and he is hereby, authorized to make, within one year after the approval of this act, such reservation of public lands and buildings belonging to the United States in the island of Porto Rico, for military, naval, light-house, marine hospital, post-offices, custom-houses, United States courts, and other public purposes, as he may deem necessary;"

And whereas the public lands in the island of Porto Rico, within the limits hereinafter described, are in part covered with timber, and it appears that the public good would be promoted by setting apart and reserving said lands as a public reservation;

Now, therefore, I, THEODORE ROOSEVELT, President of the United States, by virtue of the power in me vested by section one of the aforesaid act of Congress, do hereby make known and proclaim that there is hereby reserved and set apart as a public forest reservation all those certain tracts, pieces, or parcels of public lands, not heretofore appropriated or reserved, lying and being situate in the island of Porto Rico, and within the boundaries particularly described as follows, to wit:

Beginning at the point where the parallel of eighteen (18) degrees and twenty-two (22) minutes north latitude intersects the meridian of sixty-five (65) degrees and fifty-five (55) minutes west longitude; thence due east along said parallel to its intersection with the meridian of sixty-five (65) degrees and forty-five (45) minutes west longitude; thence due south along said meridian to its intersection with the parallel of eighteen (18) degrees and fourteen (14) minutes north latitude; thence due west along said parallel to its intersection with the meridian of sixty-five (65) degrees and fifty-five (55) minutes west longitude; thence due north along said meridian to its intersection with the parallel of eighteen (18) degrees and twenty-two (22) minutes north latitude, the place of beginning.

Warning is hereby expressly given to all persons not to occupy or use the lands reserved by this proclamation.

The reservation hereby established shall be known as The Luquillo Forest Reserve.

In witness whereof I have hereunto set my hand and caused the seal of the United States to be affixed.

DONE at the city of Washington this 17th day of January, in the year of our Lord one thousand nine hundred and three, and of the Independence of the United States the one hundred and twenty-seventh.

[SEAL.] THEODORE ROOSEVELT.

By the President:
JOHN HAY,
Secretary of State.

The reserve is located in the eastern part of the island. It covers a large part of the Sierra de Luquillo, a mountain mass separated from the mountains of the rest of the island by the valley of the Loiza, the largest river in Porto Rico, and includes El Yunque, which has always been considered the highest mountain on the island. Although mapped as 1,520 meters above sea level by Spanish authorities, it is probably not more than 3,300 feet in height. Compared with other West Indian mountains this is low. The Pica de Turquino, in eastern Cuba, is 8,400 feet; Mount Tina, in Santo Domingo, is 9,420; Blue Mountain Peak, in Jamaica, is 7,300; and Mount Misery, on the little island of St. Kitts, an old volcano which is still warm and steaming, has a height of over 4,000 feet. Although Porto Rico is mountainous, the highest peak in Jamaica is more than twice and the highest mountain in Santo Domingo almost three times as high as El Yunque.

Seen from a distance, the Sierra de Luquillo is strikingly serrated. In addition to El Yunque (The Anvil), there are at least three other big mountains, concerning the names of which no accepted native usage was discoverable. By consulting old maps and records, however, precedents were found for calling the big round mountain on the west "El Toro" (The Bull), the mountain next to it on the south "El Carnero" (The Sheep), and the mountain on the southeast "El Cacique" (The Indian Chief). It is to be hoped that the Board on Geographic Names will accept this or adopt some similar nomenclature, based, if possible, on local usage.

The high mountains are flanked by numerous lateral ridges which extend in every direction. These ridges are very sharp and are called "cuchillas." The word "cuchilla" means blade; nowhere in the world could it be more aptly applied. The crest line is often so sharp and the sides so steep that traveling, even on foot, is exceedingly difficult. The ridges separate deep gorges called "quebrados." Farther down, the hills are more rounded. A long, flat-topped or rounded ridge is called a "loma." On the western side of the reserve, between the headwaters of the Canovanas and Canovanillas rivers, the elevations of this character are well named "Lomas del Viento," or "Hills of the Wind."

The topography of this whole country is mainly the result of erosion. Were it not for the tough cover of quick-growing herbage, the conditions would be much worse. Landslides and glissades are not uncom-

SAN JUAN
RIO PIEDRAS
CAROLINA
LOIZA
CANOVANAS
RIO GRANDE
MAMEYES
LUQUILLO
FAJARDO
CEIBA
NAGUABO
AGUAS BUENAS
CAGUAS
JUNCOS
PIEDRAS
HUMACAO
MAUNABO
GUAYAMA

Río Grande de Loiza
Río Herrera
Río Canovanillas
Río Canovanas
Río Grande
Río Espíritu Santo
Río Mameyes
Río Sabana
Río Pitajalla
Río de Fajardo
Río Maracuto
Río Blanco ó de Naguabo
Río Santiago
Río Daguado
Río Anton Ruiz

18°-22'
18°-14'
65°-55'
65°-45'

El Toro
LA GLORIA
Mts. Perla
El Yunque
El Cerrote

THE LUQUILLO FOREST RESERVE
PORTO RICO

LEGEND

- PRESENT RESERVE BOUNDARY
- BOUNDARY OF FEDERAL LANDS
- BOUNDARY OF INSULAR LANDS
- FOREST
- UNWOODED

MILES
0 1 2 3 4 5

mon, and after a heavy rain the streams are usually exceedingly muddy. The violent washing of the soil during the cyclone of 1899 carried seaward vast amounts of organic matter and soil. This, it is asserted, benefited the sugar planter, whose plantations are in the lowlands, but helped to ruin the coffee grower. This benefit to the sugar planter, however, is probably more apparent than real, since he, too, suffered serious loss by the flood of mud and water and by the damage to ditches, roads, bridges, etc. Organic matter quickly disintegrates in the Tropics, and even the forest soil on steep slopes is washed away by deluges of rain.

The central or main portion of the reserve is so rugged that it has remained all these years a practically unexplored virgin tropical wilderness. The lines as proclaimed include on the north, west, and south a great deal of cleared land privately owned, and now used for the production of cane, corn, rice, and coffee, and for pasture. But private owners with good titles need feel no alarm lest they be deprived of their holdings, for this reserve consists only of those pieces or parcels of public land not heretofore appropriated or reserved. Much of the reserve is so steep and so inaccessible that provisions and farm products are carried in and out on the backs and heads of men and women and by means of canoes over extremely slippery and winding paths (see Pl. III, fig. 2). The steepness of the hillsides necessitates hand cultivation, which is fortunately shallow. On the western side of the reserve there is an immense quantity of land which should never have been cleared. Most of it is now worthless except for pasture (see Pl. II). The best timber is on the eastern side.

Within the lines of the reserve there is a broad area of cultivated land. In many places on the south the cultivation of rice extends to the very tops of the hills, more than a thousand feet in height. The upper tier of private holdings consists mostly of coffee plantations. The coffee is so much shaded in many cases that it is difficult to distinguish it from forest even at a short distance. Compared, however, with other parts of the island this is not a famous coffee district. Of the entire 65,950 acres which the reserve is supposed in all to cover, not more than 50 per cent is in forest and coffee estates. Probably less than 30 per cent is Government land unclaimed by private owners. The amount of Federal forest land, roughly estimated, is 20,000 acres. Fortunately this is almost in a solid block. The lines of private holdings which border on public lands are very vague on the upper boundaries. The description in the deeds is indefinite. The permanent fixing of this upper line will be the most perplexing but one of the most important steps in the development of the reserve. Other survey work may be postponed indefinitely, but the establishment of this line between private and public holdings can not be fixed too soon.

The topography of the reserve is exceedingly difficult to work out, in consequence of the enormous number of peaks, deep ravines, sharp cuchillas, streams, and waterfalls. A survey will require the services of several men, with complete camp equipment, for a considerable time.

On the north, east, and south of the reserve the sea is near and the rivers short. If the line is extended 3 minutes to the eastward the northeast corner will almost touch the town of Luquillo, on the coast. On the west there are many high, cleared hills and ridges, which descend to the valley of the Rio Loiza. The mountains El Yunque, El Toro, El Carnero, and El Cacique surround a large, round, and crater-like valley comparatively open to the east. In this valley some land is owned by private parties, but only a small part of it is cleared. This is the valley of the Mameyes River. This river drains a much larger territory and carries much more water to the sea than is usually supposed. The water is of crystal purity, and it dashes and foams in the form of many small waterfalls throughout its whole upper course (Pl. IV, fig. 1). Its bed is a mass of rock, worn into deep holes and strewn with immense fragments of granite. It reminds one more of a northern than a tropical stream. The reserve is drained on the east by the Rio Fajardo, Rio Sabana, and Rio Mameyes; on the north by the Rio Espiritu Sancto and Rio Grande; on the west by the Rio Grande, Rio Canovanas, Rio Canovanillas, and branches of the Rio Loiza; and on the south by the Rio Blanco. The south side is so steep that the river plunges down in a series of cascades. For that reason it is called the "White River." One branch of it, according to Mr. H. J. MacNair, civil engineer, makes a drop of 1,250 in 4,500 feet.

The map accompanying this bulletin is not accurate from a surveyor's standpoint. It is such a graphic representation as the writer was able to make after six weeks of wading and climbing through masses of bushes and vines. The stream beds, although extremely rocky and slippery, are the lines of least resistance, and along them is found the best timber. For these reasons the writer mostly traveled in and along the water courses.

ANIMAL LIFE.

Injurious animal life, in fact animal life of any kind, is strikingly absent. One can spend a long time in the reserve without seeing any wild animals except small lizards, tree toads, and a very few birds. Even insects such as butterflies are very scarce. The absence of many forms of animal life is often accounted for by the presence of the mongoose, which was introduced to exterminate rats on sugar plantations, and he has succeeded in exterminating most of the animals

within reach, but is so wary that he is rarely seen. Whether he lives in the forest or not the writer has been unable to determine. He probably dwells near the plantations. The lack of insects may be partly accounted for by the abundance of tree toads and lizards.

INSULAR PUBLIC LANDS AND SURVEYS.

After June 30, 1903, all lands not previously reserved by the Federal Government became the property of the insular government. These lands are extensive and varied in character. What will happen to them is uncertain, but the consensus of opinion favors renting for a long term of years and using the proceeds for educational purposes. These lands should be classified and surveyed, so that certain forest and waste lands may be segregated and protected and not leased, since the lease of forest or waste land to private parties for a long term of years could not be otherwise than ruinous in the end. Much of this land probably could not be leased at any price. The records of all public lands of the island, and of mineral claims, are held by a bureau of forests and public lands connected with the department of public works in San Juan.

Surveying in Porto Rico is difficult and expensive, especially in the eastern part of the island. This has never been surveyed or mapped; even the lines of Government property are not marked. People often have in consequence helped themselves not only to wood but to the land itself. What has kept this great Luquillo region virgin is the fact that it is practically inaccessible and that it is next to impossible for a native to handle big timber with the small means at his command.

On the eastern end of the reserve there is a great deal of good timberland, acknowledged to be the property of the Government. Much of it, however, is not included within the lines as proclaimed by the President. It is recommended that the reserve boundaries be extended to include these lands. The accompanying map shows the lines as proclaimed and the amount of land in the Luquillo region which belongs to the Government and which should be accounted for. This map simply shows the areas. The lines on the outside are really irregular, and within the area marked by oblique lining there is some private land.

According to the report for 1900 of the commissioner of the interior for Porto Rico to the Secretary of the Interior, United States of America, the following public properties are within or in the neighborhood of the Luquillo Forest Reserve.

TABLE I.—*Public properties within and adjacent to the Luquillo Forest Reserve.*

Towns and barrios.	Properties.	Area.	Class.
		Cuerdas.[a]	
Ceiba, Barrio Rio Arriba	Monte Sierra de Luquillo	4,561.50	Brush.
Do	Sierra	534.50	
Fajardo, Barrio Rio Abajo	Sierra de Luquillo	4,170.00	
Do	Cuchilla de Palo Quemado	713.25	Woodland.
Las Piedras, Sierra de Luquillo	Sierra de Luquillo	4,579.00	Brush.
Loiza, Barrio Cubuy		600.00	Do.
Sierra de Luquillo	Sierra de Luquillo	1,272.00	Do.
Luquillo, Barrio Pitahaya	Pitahaya	891.25	Woodland.
Barrio Sabana	Sabana	723.50	Do.
Barrio Mameyes	Mameyes	455.00	Do.
Sierra de Luquillo	Sierra de Luquillo	5,083.00	Do.
Naguabo, Barrio Rio Blanco	Sierra Luquillo	1,785.25	Do.
Rio Grande, Barrio Guzman	Nacimiento Canovanas	4,430.00	Broken.
Barrio Guzman	Lazaro	4,462.00	Do.
Barrio Guzman	Yunque	3,307.00	Do.
Yarar	Guzman	3,570.00	Woodland.
Humacao, Barrio de Rio (Baldios)[b]		4,579.00	Mountains.
Luquillo, Barrio Sabana (Baldios)[b]		300.00	Woodland.

[a] The size of the cuerda, a Spanish measure, varies in different countries. In Porto Rico, since August 7, 1883, the standard equivalent of one cuerda has been 1.0081 acres.
[b] From report for 1900.

There are, then, more than 40,000 cuerdas of land in or near the reserve which either the Federal or the insular Government owns. According to this same report (1900), of the 2,010,855 acres in Porto Rico 25,659 are brush lands, 318,897 woodland, 1,206,593 pasture, 80,034 sugar cane, 180,289 coffee, 15,324 tobacco, and 104,059 miscellaneous. According to the report for 1901, cane occupied 82,678 acres; coffee, 166,164; tobacco, 13,704; miscellaneous, 201,815; pasture, 1,203,206; woodland, 165,671; and uncultivated, 138,348.

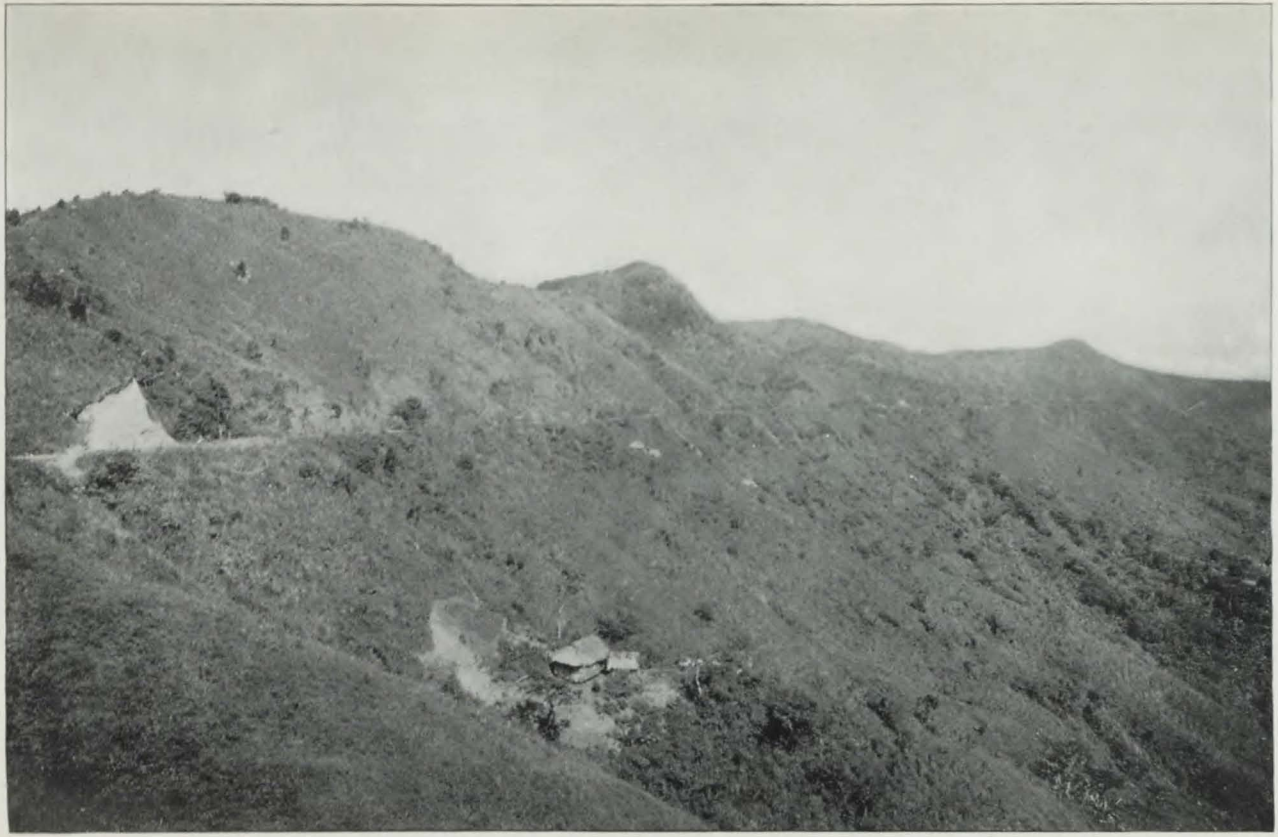
Although it is probably not safe to rely on the accuracy of these figures, it is of interest to note that more than half of the island is in pasture.

The latitudes and longitudes of places away from the coast are not known. One map places the town of Rio Grande well within the reserve; another, equally reliable, places it some distance on the outside. The nearest fixed monument that the writer has been able to find was established on the coast on a high bluff near the town of Luquillo by the United States Coast and Geodetic Survey.

CLIMATE.

PRECIPITATION AND MOISTURE CONDITIONS.

The only weather station within the boundaries of the reserve is located at the Hacienda La Perla. At this place records of rainfall and temperature have been kept for fifteen years. The trade winds, which blow almost throughout the whole year, are from the eastward.



CHARACTER OF THE CLEARED LAND SOUTHWEST OF THE RESERVE.

This land was once forested, but most of it is now worthless pasture land, which is growing up in brush and weeds. Dry part of the island. In the foreground is a native hut with a small clearing for the cultivation of vegetables. The white spots are the cabins of natives.

These winds, although seldom severe, are constant—so constant, in fact, that the trunks and crowns of trees exposed to their influence bend strikingly to the westward (see Pl. III, fig. 1). These winds are laden with moisture, and since the high mountains of the reserve are close to the eastern shore, they are drenched with rain. This accounts for the luxuriance of the vegetation in the sheltered portions of the reserve. The precipitation is probably intensified by the fact that the mountains form a U-shaped basin, with its opening toward the east. The Hacienda La Perla, which is located about 500 feet above sea level, receives the greatest rainfall recorded on the island. As one ascends the amount increases until the top of El Yunque is reached, where twelve hours without rain is an exception. For the year 1902, 140.75 inches of rain fell at La Perla. The greatest monthly rainfall at La Perla for the year was 33.3 inches in June. It seldom rains for a great length of time, except during severe storms. The rain usually falls in the form of drenching showers, followed by bright sunshine. The water drops with such pelting force that ordinary umbrellas and mackintoshes are of little use. These showers are usually very local in character, so that one can often watch and hear them in the distance. So sudden and heavy are the downpours in the mountains that a quiet brook becomes a raging torrent and subsides again to its normal condition in a couple of hours. The writer has seen the fords of the Mameyes River become impassable in thirty minutes, and subside again in about the same length of time. The air is so humid, vegetation so dripping, and perspiration so profuse that, once wet, one remains wet throughout the day. Fortunately there is less rain in the daytime than at night. There are very few nights in the year when no rain falls at La Perla.

Parts of the island are drenched with water most of the time; other parts within half a day's ride are dependent upon irrigation. In parts of the island the rainy and dry seasons are pronounced, but on the reserve it is rainy throughout the year.

At La Perla there are two rain stations, one at 500 feet and the other at 1,200 feet, but the climatic difference between the two is surprisingly small. The precipitation at these stations for 1901 and 1902 is shown by the table following.

TABLE II.—*Monthly and annual precipitation for the years 1901 and 1902, with departures from the normal.*[a]

Month.	Hacienda Perla.			
	500 feet.		1,200 feet.	
	Precipitation.	Departure.	Precipitation.	Departure.
1901.	*Inches.*	*Inches.*	*Inches.*	*Inches.*
January	5.57	− 2.42	6.07	− 2.23
February	1.52	− 1.22	1.85	− 1.18
March	9.47	+ 2.69	11.03	+ 5.18
April	5.56	− 5.63	7.05	− 4.82
May	17.64	+ 2.89	16.26	+ 0.82
June	24.64	+12.22	25.34	+12.78
July	33.57	+16.30	33.58	+17.36
August	7.80	− 4.14	8.19	− 3.06
September	16.78	+ 4.06	16.10	+ 2.82
October	15.08	+ 0.32	14.16	− 0.06
November	18.30	+ 0.51	16.43	+ 1.78
December	13.03	+ 3.85	11.67	+ 2.35
Annual	168.76	+29.43	167.73	+31.74
1902.				
January	12.56	+ 3.80	13.99	+ 4.87
February	0.26	− 2.13	0.24	− 2.39
March	7.69	+ 1.75	7.25	+ 1.25
April	9.40	− 1.53	9.94	− 1.69
May	19.62	+ 3.13	19.83	+ 3.76
June	33.30	+17.90	32.92	+17.37
July	9.77	− 6.43	10.08	− 5.26
August	7.17	− 5.52	8.13	− 2.68
September	9.70	− 2.59	10.06	− 2.77
October	6.31	− 7.25	6.06	− 6.99
November	12.96	− 5.01	13.03	− 4.40
December	12.01	+ 2.42	9.64	+ 0.13
Annual	140.75	− 1.46	141.17	+ 0.94

[a] Weather observations at these stations began in 1896. "Normal" is therefore for 1901 an average of six and for 1902 an average of seven years.

The driest month of the year is probably February, and the wettest, November.

In spite of the warmth and constant moisture, the vegetation in those places above 2,000 feet which are exposed to the winds and washing consists of little more than brush. This is somewhat remarkable; in temperate regions and in other places in the Tropics the timber line often reaches a height of 5,000 feet, if not more. The writer believes this condition to be due to a combination of circumstances—first, strong winds; second, so much moisture that the conditions are practically swampy; and, third, the beating and washing of the soil by heavy rains. The heavy clay soil, when saturated with moisture, lacks air and such animal life as earthworms, which loosen, ventilate, and fertilize it. Even when it is not actually raining the

mountains are so bathed in mist and fog that there is a constant drip from the branches to the ground. The brush is covered with cold, clammy masses of moss, which hold water like a sponge (Pl. V, fig. 1). Lieut. N. F. McClure, who ascended El Yunque, states in an article in the Sierra Club Bulletin that bushes which were cut nine months before had green trunks and leaves. They were still living, and apparently as fresh as ever.

This much is certain, that there is sufficient warmth and sufficient moisture to produce tropical luxuriance in the sheltered coves and valleys. Immediately to the south and west conditions change. The country is drier, evaporation more active, and the vegetation more droughty in character. This change is noticeable even within the limits of the reserve.

TEMPERATURE.

The highest temperature recorded in 1902 on the whole island was 98°—at Morovis on June 4, at Cayey on August 19 and other dates, and at Hacienda La Perla on September 4. This would seem to indicate that the Luquillo region is one of the hottest parts as well as the wettest part of the island. The lowest temperature at La Perla was 60°, on May 14. The annual mean was 77.8°.

EFFECT OF THE CLIMATE UPON INDUSTRY AND HEALTH.

The effect of the climate upon the lumber industry and upon the health of those persons who will have to manage this reserve are matters of much importance. Not to mention the density of the jungle, the abundance of worthless weeds, the absence of roads and trails, and other difficulties, the frequent rains soften the soil and render even narrow mountain paths impassable. The heat and rain interfere with forest work to such an extent that even with the best of workmen only a small part of what is accomplished in the States may be expected. In spite, however, of what might be said to the contrary, the writer believes this region to be healthful compared with other tropical districts, or even with our Southern States. The water which comes from the mountain streams is pure and healthful, and may be consumed in large quantities without deleterious effects. This applies only to those streams which come from forested, uninhabited watersheds, and which are not used for the purpose of clothes washing. The region is free from mosquitoes, flies, and other obnoxious insects. Even the house fly is practically absent. The danger to health lies in three sources. The first is overexposure to the hot sun. This is slight in the forest, and is easily avoided. The second danger is from lack of proper food. The person who depends upon the native supply will fall a victim to stomach troubles, which are difficult to cure in the Tropics. The third, the most serious and one which seems impossible to be avoided, is getting

wet. In spite of all precautions one is usually wet most of the time. Woolen clothing becomes heavy and oppressive, yet without it there comes a chill the moment one stops to rest or wait. Overexposure of this kind, although it may not be the direct cause, inevitably leads to malarial fevers, dengue, and tropical dysentery.

The climate of Porto Rico differs as to temperature and precipitation within a remarkably short distance. The island seems extensive in traveling from place to place, because of its roughness; but to look down upon it from the top of El Yunque or of any high mountain of the island, it seems small indeed. It is in fact smaller than most of the southern counties of Florida (3,608 square miles), yet within its limits there is every degree of climatic conditions except frost and cold; even hailstorms have occurred. The whole island is little more than half the size of the Sierra Forest Reserve, California, the Bitter Root Forest Reserve, Idaho and Montana, or the Cascade Range Forest Reserve, Oregon, while there are a dozen more in the United States which equal or approximate its size.

The nights are never hot, and the wind, although constant, is balmy. There is little danger from colds from drafts and open windows.

EFFECT OF WINDS.

One climatic factor of paramount importance in Porto Rico is the constant trade wind. Throughout the island vegetation is constantly lashed by this steady current of air, always in one direction, so that the trees on hilltops and elsewhere where unprotected are stunted and bent to the westward. (Pl. III, fig. 1.) Successful cultivation of fruit, coffee, cacao, and similar products is dependent upon windbreaks. It is only in sheltered situations that luxuriant tree growth is found. A series of windbreaks of such trees as mango, casuarina, etc., would be of inestimable value to the various industries of the island. In the production of coffee it is not so much the shade which the nurse tree affords that is of benefit as the protection from wind and other injurious influences. Hurricanes as a rule occur only during the months of August and October, when the eastern trades become unsteady and uncertain.

THE FOREST.

GENERAL DESCRIPTION.

The statement has been frequently made that the island of Porto Rico was originally mantled with forests from the level of the sea to the summits of its highest mountains. This is without doubt an exaggeration, the extent of which is dependent upon the meaning given the word "forest." If brushlands on mountain tops and a sparse growth of chaparral in dry districts is considered forest,

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FIG. 1.—WEST INDIAN ALMOND TREES (TERMINALIA CATAPPA) DISTORTED BY TRADE WINDS.

FIG. 2.—CANOE USED FOR OVERLAND TRANSPORTATION.

The boy holds a coil of rope manufactured from the "emmajagua," the shrub in the background.

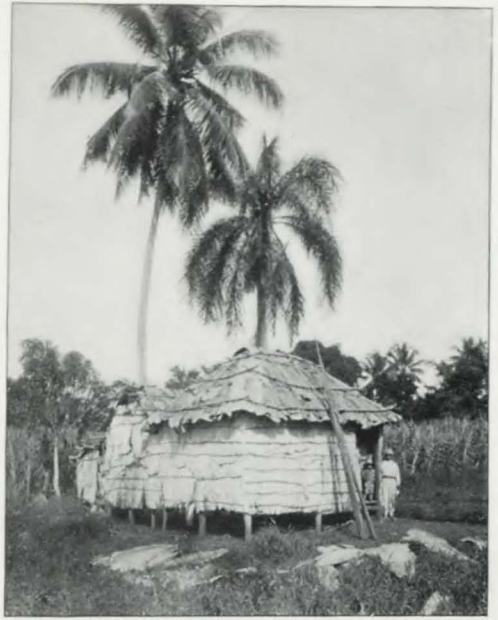

FIG. 3.—COCOANUT AND ROYAL PALMS. CHARACTER OF NATIVE CONSTRUCTION.

TYPICAL SCENES IN THE LUQUILLO REGION.

this statement is fairly correct, although there are large areas which, in consequence of poor soil, drought, or strong winds, have never been truly wooded. Because of the rapid evaporation and the impervious soil a large quantity of well-distributed rain is necessary. With the same amount of rain that falls in several of our Eastern States, Porto Rico would probably present a very droughty appearance. In those parts of the island which are free from excessive winds, and where the rainfall is plentiful and well-distributed throughout the year, there was, and in several places is still, a heavy growth of timber. The Luquillo forest is such a growth. Its most prominent characteristic is its diversity and the great number of little-known species in mixture. This makes it extremely difficult to divide into silvicultural types and to estimate the amount of timber, and would make it still more difficult, if not impossible, to determine the annual accretion. It is rare indeed to find trees of the same species in considerable number together. The tree which is most strikingly gregarious in habit is the mountain palm, or palma de sierra (*Acrista monticola* Cook). This tree is of no value whatever from a commercial standpoint. Of the timber trees tabanuco is also noticeably gregarious. (Pl. IV, fig. 2.)

Throughout the West Indies, and indeed throughout the tropical world, the sea-coast sylva is more or less uniform. To the species constituting this sylva the fertile low coastlands of Porto Rico offer ideal conditions. They afford the proper amount of moisture, the proper amount of warmth throughout the year, suitable soil conditions, and few destructive agencies. There is consequently slight struggle with the forces of nature; there is only the competition among the individuals of the forest itself, and the most luxuriant type of vegetation develops (see Pl. V).

From the similarity of conditions and the small play of environmental selective agencies it might be supposed that protected valleys in practically the same altitude would show the same mixture. Such, however, is not the case. From quebrado to quebrado there is considerable variation. With this condition man's interference, by removing certain species valuable to him and allowing others, usually of an inferior kind, to usurp their place, has probably had much to do. The effect of location also plays a part; the trees of south and west slopes present distinct differences from those of east and north exposures. But to a large extent the distribution of species is more or less a matter of accident. Trees have grown wherever the many means of distribution have dropped the seeds and where they have found conditions suitable to their needs. Here and there one meets single trees or little groups of trees which he may never see again on the reserve, as in the case of the mago (*Hernandia sonora* L.), which the writer found only in one locality, near Santa Catalina. This species is also a native of the East Indies, as well as the East Indian pomerosa,

or rose apple, now quite as common in Porto Rico as any indigenous species. On the whole, then, the forest growth of the island is far from uniform, although the causes which have brought about its local differentiation are for the most part not of a kind to afford a basis for classification into types.

In spite of the smallness of the island and the absence of very high elevations, certain trees show so great a diversity in habit of growth in different localities that a species which in some places grows to be a large and beautiful timber tree, elsewhere barely exists in the form of a bush or shrub. In sheltered fertile coves the laurel sabino, for instance, becomes large and valuable timber (see Pl. VI, fig. 2); in exposed situations, where the beating of the wind and washing and pelting force of the rain are strong, the tree is gnarled and bushlike in character. This is true of several species, and within small limits of area. In fact, variation of this kind may occur on the two sides of the same ridge.

FOREST BETWEEN 500 AND 2,000 FEET ALTITUDE.

The sole distinction of forest types which can be made within the reserve is the division into low and high mountain forest. First in importance is the forest which grows in the fertile gorges, ravines, and coves, protected from strong winds and other injurious influences, and lying between the altitudes of 500 and 2,000 feet.[a] This is the truly timbered area, rich in species and forest weeds, but with the four best timber trees—tabanuco, laurel sabino, ausubo, and guaraguao—predominating (see Pls. VI and VII). Of these the ausubo is the scarcest and most liable to early exhaustion. The natural reproduction of this species is only fair. Next in order is laurel sabino, not so scarce, and reproducing itself wherever possible. Guaraguao comes next, in considerable abundance, with fairly good reproduction; and then finally tabanuco, which is likewise plentiful, and reproduces freely.

Owing to the difficulty of handling heavy logs, the largest specimens have been left by the natives. These are of course fine seed trees. One advantage of a rough country such as this is that seed trees and patches of virgin growth are left in the inaccessible places.

Associated with these important species there is a host of others of more or less value, such as moca, granadilla, palo colorado, etc. There are also many climbing vines, such as "Juan caliente" (Hot John) (see Pl. V, fig. 3), and a species of grass which cuts like a razor. After traveling some distance through this grass one's hands and face are covered with cuts and blood. It grows as high as the face, and cuts on the slightest touch.

[a] Below 500 feet elevation is the common sea-coast sylva, which is more or less uniform throughout the West Indies. Only a small part, if any, of the forested portion of the reserve is below this elevation.

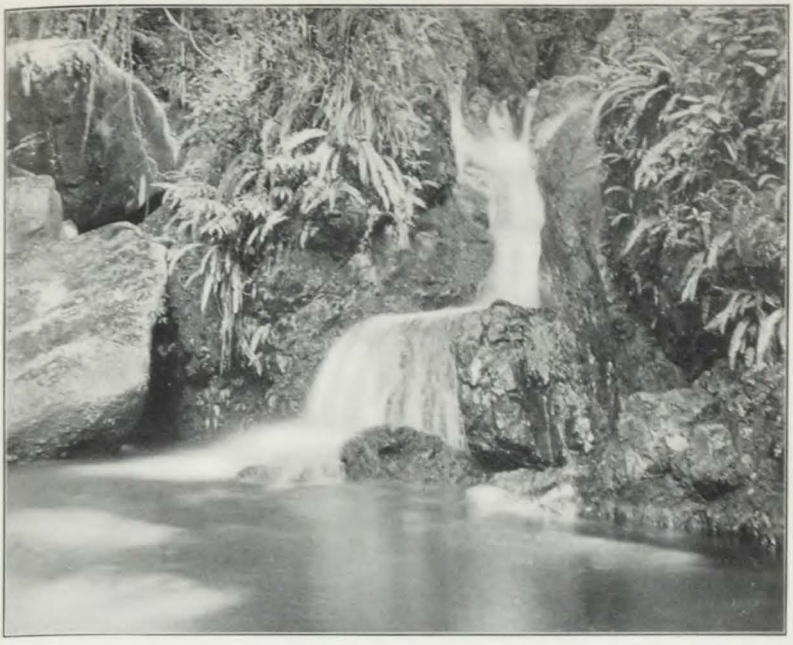

FIG. 1.—WATERFALL ON A BRANCH OF THE RIO SABANA WITHIN THE RESERVE.

Considerable gold has been washed from the gravel of this branch. Rocky character of stream bed. Similar waterfalls are numerous, and their power might be utilized for various industries.

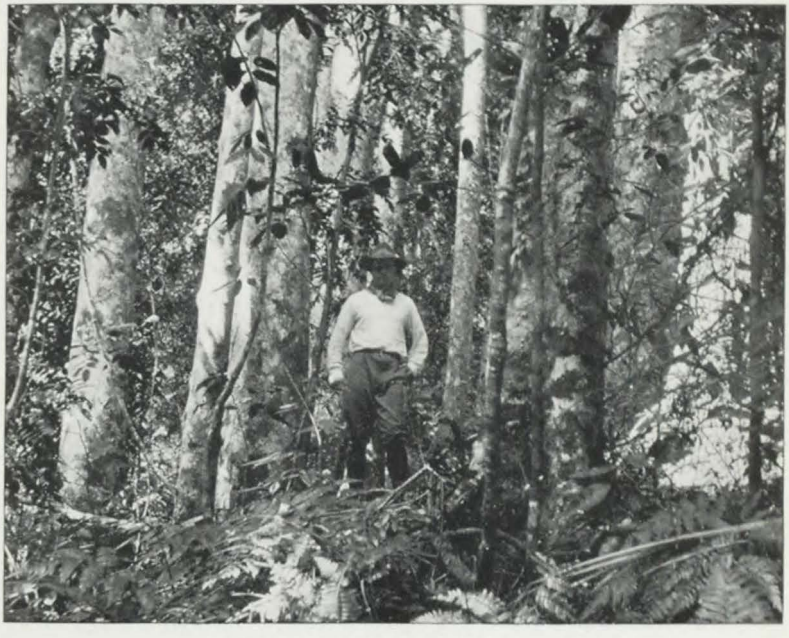

FIG. 2.—CLOSE STAND OF YOUNG TABANUCO.

Close inspection shows machete cuts on the trees on the right. These cuts are made for the collection of gum.

Here and there in this zone there are groups of mountain palms. This tree has, and apparently has always had, complete control of extensive areas. It grows thickly and produces an immense amount of seed. This, which is larger than a Spanish pea, germinates easily and quickly on the wet surface of the ground. When an old tree falls there are many to take its place. In looking down upon the interior basin from the top of El Yunque it appears like a sea of palms with islands of dark-leaved hardwoods here and there. Probably 50 per cent of this fertile basin is covered with these palms. They are truly forest weeds. With their tall, straight stems and broad leaves, they are very beautiful and extremely tropical in appearance. They grow to the height of 40 feet, and their leafage resembles that of the royal palm. The trunk, however, is straight and not bulged. If this territory is ever utilized for timber production, the extinction of this palm will be a necessary but difficult operation. By introducing pigs to eat the seeds, and by dibbling in seed of valuable timber trees, it might be possible to bring about their eventual displacement. From appearances, when once firmly established, they are ever after able to hold their own against other species.

HIGH MOUNTAIN FOREST.

Above the 2,000-foot mark, and in exposed places lower, there is another kind of growth. This is a stunted, gnarled, slow-growing vegetation, made up of many species. The limbs are moss covered, and the roots in many cases bare. These are the rough mountain tops, with which nothing can ever be done from the standpoint of forest management. They should remain always just as they are. This timber, even if it could be used, is worth a thousand times its commercial value in holding the soil on the mountain tops and in restraining the floods, which are already formidable enough.

TIMBER PRODUCTION.

Excluding, then, the area in palms and the area in brush, there is left a belt of mixed timber close to the lines of the coffee plantations. For this reason the establishment of the lines of the upper tier of owners is important. Here is the best timber, and it is from here that timber is being stolen, because it is accessible.

Of the 20,000 acres, which is approximately the amount of Federal forest land, fully 50 per cent is in mountain peaks and palm lands. There is left, then, only about 10,000 acres of timber forest. It is the writer's opinion, based on a rough eye estimate, that an average yield of 2,500 feet of merchantable timber to the acre is a very liberal allowance. This would give, in all, not more than 25,000,000 board feet. The tables following illustrate the representation of species.

TABLE III.—*Representation of species on one-eighth acre of very rough virgin land.*

Diameter breasthigh.	Tabanuco.	Guara.	Yaya.	Laurel sabino.	Palo colorado.	Ausubo.	Mangle.	Leche.	Guayabacon.	Caracolillo.	Cucubano.
Feet.											
0.0–0.1											
.2											
.3			1								1
.4		1	1			1	1	1	1	1	
.5	1										
.6											
.7	2										
.8					1						
.9	1										
1.0											
1.1	1										
1.2	2										
1.3	1										
1.4	1										
1.5											
1.6	1										
1.7	1			1							
1.8											
1.9	1										
2.0											
2.1											
2.2	2										
Total..	13	2	2	1	1	1	1	1	1	1	1

TABLE IV.—*Representation of species on one-eighth acre on very rough hilltop cut over for ausubo.*

Diameter breasthigh.	Tabanuco.	Ausubo.	Yagrumo.	Camacey.	Laurel sabino.	Dajao.	Guayabota.	Gallina.	Cupero sapo.	Maricao.
Feet.										
0.0–0.1	50	25								
.2										
.3										
.4										
.5	1		1							1
.6	1		1						a1	
.7				1				1		
.8				1			1			
.9										
1.0										
1.1										
1.2										
1.3						1				
1.4	1									
1.5	1									
1.6										
1.7										
1.8										
1.9										
2.0					1					
Total..	54	25	2	2	1	1	1	1	1	1

a40 feet high.

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FIG. 1.—HIGH MOUNTAIN FOREST.

A stunted growth of gnarled hardwood, covered with moss and ferns of no commercial importance, but of great use as a protective cover.

FIG. 2.—PORTO RICAN TREE FERNS.

FIG. 3.—TRUNK OF AN AUSUBO TREE IN LOWLAND FOREST.

Note the abundance of climbing woody vines, which would seriously impede lumbering.

CHARACTERISTIC VIEWS IN THE LUQUILLO FOREST.

TABLE V.—*Representation of species on one-quarter acre on hillslope cut over for ausubo long ago.*

Diameter, breasthigh.	Tabanuco.	Ausubo.	Aguacatillo.	Camacey bobo.	Yagrumo macho.	Cacao motillo.	Gallina.	Guara.	Guayabacon.	Laurel sabino.	Granadillo.	Guajon.	Caracolillo.	Miscellaneous.
Feet.														
0.0-0.1	75	15	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	100
.2	.....	.....	.....	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
.3	.....	.....	.....	1	.....	.....	1	.....	1	.....	.....	.....	.....	.....
.4	.....	.....	1	1	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
.5	1	.....	1	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
.6	2	.....	.....	.....	1	.....	.....	1	.....	.....	.....	.....	.....	.....
.7	3	1	1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.8	1	1	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	1	.....
.9	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.0	4	.....	.....	.....	.....	1	1	.....	.....	.....	1	a1	.....	.....
1.1	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.2	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.3	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.4	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.7	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.8	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
1.9	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.0	2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.2	b1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.3	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.4	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.5	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2.6	.....	.....	.....	.....	.....	.....	.....	.....	.....	c1	.....	.....	.....	.....
Total ..	98	17	3	3	3	2	2	2	2	1	1	1	1	100

a 50 feet clear length. *b* 40 feet clear length. *c* 60 feet high.

It is very difficult to determine the rate of growth of these species. Hard, dense woods are not necessarily the slowest growing. The annual ring, if it exists at all, does not mean much in this district. Growth is more or less constant, and there seems to be no periodicity of leaf fall whatever. It seems to vary with the same species growing under the same conditions. The dry season is not sufficiently pronounced to make its mark on wood production. No doubt when the tree flowers and fruits there may be some registry of this function in the wood. Tropical trees seem very erratic about blooming, fruiting, and even leaf shedding. The tropical almond may produce one, two, or no crops of fruit in the course of a year. One tree may be evergreen in some districts and deciduous in others. There is probably some cause back of it all, but the way tropical trees have of apparently doing as they please, in season or out of it, in shedding leaves and

bearing fruits, is hard to explain. Every activity of this kind is no doubt recorded in the wood, but the botanist who tries to work it all out will have plenty to do for some time to come. This reservation would make an excellent place for a tropical botanical headquarters. Each tree in such a climate seems to have its own specific habits of growth, subject to variation as to time and intensity. Whether there is such a thing as a seed year in the Tropics is doubtful. Introduced species, like the poinciana, no doubt follow more or less the habits acquired in their native land.

Except on plantations where patches of pomerosa and other trees have been grown for fuel or barrel hoops there is seldom clear cutting. Where the forest is accessible culling begins with the best timber, and proceeds until inferior kinds only are left.

Although there are extensive pine woods in both Santo Domingo and Cuba, I was unable to find any native pines in Porto Rico. The so-called Australian pine has been planted here and there, and grows well on the coast. This, however, is not a pine at all, but *Casuarina equisetifolia* Forst.

Doubtless many seashore species, like lignum vitæ, cobana negra, and cocabola, will grow in the hills. The cocoanut and the mountain palm now grow side by side; indeed, there are few places in the hills where the cocoanut will not thrive, except on the mountain tops; yet the cocoanut is usually associated with ocean brine.

SURFACE SOIL AND HUMUS.

It is only in the dense forest, in places protected from erosion, that one finds much humus; indeed, humus such as we have in the North is everywhere scarce. The soil is simply blackened by the decayed vegetable stuff. Decomposition is, of course, extremely rapid in such a wet, warm country. There is no such thing as duff, except, perhaps, in the highest mountains, where there is much moss. This decomposed matter mixes with the soft, wet clay to form one of the most trying muds imaginable. On the hillsides even in the forest this surface stuff washes away. In consequence of the stiffness of this tenacious clay, the rootage of trees is shallow. Aeration of the roots is imperfect, especially when the soil is saturated with water. The condition is akin in character to swampiness. Roots are often completely washed bare, so that in traveling one must step from one slippery root mass to another.

PROTECTIVE USEFULNESS OF THE FOREST.

All this serves to emphasize the fact that this forest, and much more of it, is essential to the welfare of Porto Rico from a protective standpoint. But for it much of the fertility of the hills would have washed long ago into the sea, which is only a few miles distant. The moun-

tains would be bare rocky and clay masses, and the streams which rise there would be floods from almost every mountain shower. Because of their shortness, heavy descent, and the violent downpours they are already boisterous enough. It is hard to predict what would happen were the Sierra Luquillo completely deforested. The Mameyes, which rises in these hills, is clear even when flooded, while the other rivers when swollen are masses of yellow mud.

The limpid mountain streams constitute one of the greatest resources of Porto Rico. Along them the people congregate. They furnish the public water supply in a land without wells. Here the inhabitants water their horses and cattle, bathe, wash their clothes, and wash out gold. On the south the water is of great value for irrigation purposes, and throughout the reserve there is much power in the hundreds of waterfalls. If the forest of the Luquillo should do no more than to regulate the flow and keep pure and limpid the water of these streams, its reservation and care would be more than justified.

On an old map of the island of Tobago, made before Queen Victoria's time, there is a mountainous area marked "Reserved in forests for rain." Even so long ago the English people realized the necessity of such reservations.

The work of floods is everywhere apparent in Porto Rico. Huge bridges, which cost thousands of dollars, have been washed away, and have never been rebuilt (see Pl. VIII). On the bare southern side of the island a mere dry, rock-strewn arroyo develops in the rainy season into a dangerous torrent. There is one such near Ponce which has threatened on more than one occasion to wash the city into the sea. Roads have been damaged to the amount of many thousands of dollars, farms and pastures have been ruined, and lives have been lost. Nowhere is a dense forest growth more needed on the hills than in Porto Rico.

FOREST AND OTHER INDUSTRIES.

The industries in the neighborhood of the reserve are almost wholly agricultural. Except for sugar, hides, and coffee, which are exported, the region yields barely enough to support the native population, which subsists mainly on bananas, yautia, rice, and other similar products raised in little patches on the hillsides. When the fertility of one patch is exhausted another is cleared and cultivated and the old patch is allowed to grow up in weeds, brush, and grass. No manure is produced, because the animals are pastured throughout the year. No fertilizer of any kind is used. Cattle, goats, and horses pasture on the uncultivated areas. All these animals and even pigs are tethered in places which are not fenced. Animals are seldom seen running at large.

The commonest wood in use in Porto Rico to-day is yellow pine from

the States. The writer saw a few arborvitæ shingles and spruce clapboards from New England in Fajardo. A favorite wood in some districts is second-growth white pine, similar to the grade used for box stuff in the North.

There is a cigar-box factory in Rio Piedras which uses wood imported through New York. No doubt guaraguao could be satisfactorily used for this purpose, although it lacks the lasting odor of *Cedrela odorata*, the true cigar-box cedar.

The posts for houses are usually cobana negra and mangrove. This mangrove is dug out of the mud where it has lain for many years. As with the "mud shingles" of southern New Jersey, the slow but perfect seasoning in the mud renders this timber almost everlasting.

The houses of the peons are constructed of various materials which cost them nothing, such as poles, grass, palm leaves, etc. (see Pl. I and Pl. III, fig. 3). Near the towns old tin, dry-goods boxes, and similar materials are used, and would probably be used even if wood were cheap and plentiful. The houses are built usually on land belonging to other people; they are built quickly and easily, and are usually more or less temporary. They are cool, comparatively clean, and are perhaps better fitted to the climate and conditions than any other kind of structure. The country people are not peons in the strictest sense of the term, because a state of peonage does not exist in Porto Rico. Many of them are, however, more or less strongly attached to certain estates, and some of them are under obligations of various kinds to the proprietors. The fences are usually first-rate in character, consisting of live posts or hedges, reenforced with barbed wire and the impenetrable penguin or "piñuela."

EFFORTS AT LUMBERING.

A few people are engaged in working and hauling out timber. There is no sawmill in the eastern part of the island of Porto Rico. American single-bitted axes with straight handles are used. Trees are felled and cut into short logs with crosscut saws. There are men throughout this district who make sawing a specialty, own their own implements, and work by contract. The timber is sawed into boards in the woods on a rough staging built of poles tied together with withes. A sidehill is chosen for the location, and the process is the same as the old pit sawing, which is still practiced in modified form throughout the whole world where timber is not very plentiful and where labor is cheap. The system in Porto Rico is slightly different from that customary elsewhere, in that the stick is first squared and then the boards or plank are cut, but not completely severed. A knob is then cut in the end and the stick is hauled down slippery paths and through much mud until some road is reached. By the time the landing place is reached these sticks are worn as smooth as though planed. The oxen

FIG. 1.—THE PALO COLORADO, A LARGE FOREST TREE IN THE EASTERN PART OF THE RESERVE.

FIG. 2.—THE LAUREL SABINO.

FIG. 3.—THE AUSUBO.

IMPORTANT TIMBER TREES OF THE RESERVE.

are yoked by their horns, and the timber is chained to the yoke. Stakes driven along the paths prevent the stick from sliding down hill in turning sharp curves. The big-horned oxen, with heads to the ground, groaning and often bleeding from sharp goads, plunge recklessly down the narrow paths. A man behind yells a warning, and the traveler on horseback or afoot must often turn back until he finds a place wide enough for a turn-out. Sometimes the timber is cut into boards and carried out on the backs of men.

Although there is plenty of good water power for sawmills, they would probably not pay. The country is so cut up by narrow quebradas, or gorges, that the area from which wood could be profitably collected is in almost every case small. Even if all the wood in a district were accessible, a small sawmill would soon consume it. There is seldom much of the same species of wood in the same district, and it would require a great variety of saws to cut all the timbers, which vary from the lightness of cork to the weight of ebony. It seems that the only way to handle these timbers successfully would be to bring them in the rough, after roads and trails have been constructed, to a central factory, where they could be economically manufactured into the kinds of articles for which they are most fit. In the manufacture of fine cabinet work the native carpenter is an adept. It is only in this way that these timbers can be profitably used, since for ordinary construction purposes imported timber, especially yellow pine, can be sold in the local market at a cheaper price. A trade in wood carving similar to that of Sorrento, Italy, and of Switzerland could be easily developed in Porto Rico. It would furnish much instructive and remunerative labor to the poor natives.

CHARCOAL AND GUM.

The manufacture of charcoal is an important industry, since charcoal is the main fuel of the island. It is a fuel which can be successfully used in a country without stoves and chimneys. In the manufacture of this material limbs, poles, and other materials unfit for other purposes can be profitably utilized.

Another interesting forest industry is the collection of tabanuco gum. In almost all the markets of Porto Rico torches made of this gum, wrapped in a banana leaf, are for sale. To secure this, many tabanuco trees throughout the reservation have been hacked with machetes (Pl. IV, fig. 2, and Pl. VII). They have not, however, been seriously injured, and to all appearances a tree of this species, with care, will yield a large quantity of gum throughout its life, beginning when about 8 inches in diameter, without being seriously injured.

GOLD WASHING.

Another industry is gold washing. After every heavy rain, large quantities of gravel are washed down the rivers of the eastern part of

the reserve (Pl. IV, fig. 1). This gravel contains considerable gold—not enough to make bonanza fortunes, but enough to pay a laborer for his work. Men, women, and children may be seen all along these streams in the forest, singing and chattering while they hunt for treasure. Groceries are bought with this gold dust. Hundreds of natives wash gold when there is no other work, and thus earn on the average about 25 or 30 cents a day. Many, however, would rather work in the field, because being constantly wet sooner or later impairs their health.

SUGAR, FRUIT, AND COFFEE.

The sugar and fruit industries are extending, but the coffee land is neglected, unprofitable, and rapidly deteriorating. Much of it is going back to forest, much is being sold for taxes, and probably much more will be sold before conditions improve.

Coffee was at one time the principal product of the island. The region of the reserve is, however, probably not a good coffee district. Although all sorts of expert opinions are extant on the subject, according to good authority coffee needs a temperature of from 55° to 80°, and an elevation of 2,500 feet. It is said also that it can not endure wet or exposure, and needs a loose, loamy soil. These conditions certainly do not prevail in the region of the Luquillo Reserve. To-day the coffee hardly pays for the picking. This is true, however, not only in Porto Rico but in many other coffee regions of the world. The deterioration of this industry in our insular possessions is unfortunate for several reasons. It furnishes labor of an easy sort for men, women, and children for a considerable portion of the year; it is a semiforest crop of such a nature that the soil is protected; as a soil fixer and protector, with its shelter growth of leguminous trees, it is next best to the forest itself; it grows in a cool, refreshing atmosphere, remarkably free from unhealthy influences and obnoxious insects. A shade tree can be selected which will afford the necessary protection and at the same time yield timber. A happy combination of forestry and agriculture may here be practiced successfully. If coffee must go, it is to be hoped that tea, cacao, or rubber will take its place.

In times past a few acres would yield a good livelihood; but the overproduction in Brazil, where on the level ground the berries can be swept into piles as they fall, means failure to the Porto Rican and Hawaiian grower, who must pick his berries from the tree. If the price of coffee should be doubled to the grower, the depression in Porto Rico would subside and thousands of acres unfit for other purposes would be converted into hundreds of small but prosperous farms. This year the owners of several coffee estates in the neighborhood of the reserve were debating whether to pick at all. In the meantime the coffee ground is growing up in rank vegetation. In fact,

if conditions do not improve, and improve soon, there will be more abandoned land in Porto Rico and many more natives with nothing to do but to wander about in search of wild fruit and gold dust. The coffee industry and forest industries are intimately associated in this district.

MINOR PRODUCTS.

In addition to gold there are other minerals of considerable value within the reserve. The writer has been unable to find records of any mineral claims within the forested part of the reserve.

Certain subsidiary forest industries may be worthy a trial in the Luquillo district. It is probable that successful rubber culture may be practiced in this region. The Central American rubber is said to thrive well in the vicinity of Baracoa, Cuba, which is not unlike eastern Porto Rico in character. Perhaps also on the dry, rocky hillsides of the south side the Ceara rubber will grow.

Some cacao is growing well in the Luquillo region. It requires conditions similar to coffee, and, like coffee, is a semiforest crop. Kola also is worthy of a trial. There are places with conditions probably suitable for the propagation of allspice, as in Jamaica, and of cloves, cinnamon, camphor, Brazil nuts, bay trees, cinchona, kapok, and a host of other trees yielding oils, dyes, medicines, waxes, and gums. Logwood, which is extensively shipped from Jamaica, Cuba, and Santo Domingo, was not seen in Porto Rico.

There are many cocoanut trees on the eastern end of the island and well up into the hills. These grow close to the shore and break the force of the constant wind. The water of the green nut is a great blessing in places where the water supply is dangerous. These nuts are shipped in considerable quantity from Fajardo, with hides and sugar, in sailing vessels. At one place near Naguabo there is a small factory for the manufacture of copra. The coir also might become an important article of export.

There is opportunity for improvement in the method of charcoal manufacture. It is done only in a small, crude way by natives here and there, who use brushwood and sticks of all kinds. A few modern kilns could be easily constructed in this district. By a little business organization and training the natives could be directed in the manufacture of many useful and fancy articles from the great variety of native woods. Many of these are fit for the manufacture of furniture, but unfortunately many tropical woods crack and split when transported to another climate.

The collection of the cotton from the seed pods of the ceiba tree and the goano (called kapok in Java), ought to prove a remunerative industry, since this material is much used in stuffing mattresses, etc., and is shipped to the United States from the East Indies. The oil and cake from the seeds is also of value.

The natives are bright, hospitable, and willing to work. They are skillful in making articles of daily use from materials at hand, and are a much more hopeful class than the natives of the cities. Although the peons are often condemned as lazy and good-for-nothing by energetic and impatient settlers from abroad, they will work from early in the morning until dark for 40 cents, and will subsist on a small ration of rice, beans, and codfish. Given plenty of work, enough to eat, and rural schools for their instruction, these people will soon develop into fairly good citizens. My guide in these hills could walk all day, wielding a machete to cut his way, and at the same time carry a weight of 50 pounds through the rain and the hot sun. His great ambition was to own a gold mine and to have his children educated. These natives are almost invariably polite and generous.

There are no settlements in the forest, and no houses or cleared land within the forested portion of the reserve, except in the cleared portion of the Mameyes Valley, in which a few people are living. Banana patches, now neglected and wild, may be found here and there along the streams. These, I was told, marked the camping places of gold hunters.

INJURIOUS INFLUENCES.

GRAZING.

West of the reserve there are many acres of semipasture lands, but there is no grazing whatever in the forest itself. No injury apparently has ever resulted to the forest from this cause. The tangle is so dense and the country so rough that domestic animals would soon get lost if they could enter it.

FIRE.

Absolutely no injury has come to the forest from fire. Without a tabanuco tree handy, with plenty of gum, it would be almost impossible to start a fire, and even if it were started a shower would soon extinguish it. I saw one or two tabanuco trees charred on the outside. These were probably purposely fired by some native to secure honey or for some other purpose.

DEADENINGS.

"Deadenings" may be seen here and there, where undesirable trees have been killed by girdling for the purpose of growing coffee. These spots are unsightly, but it is a cheap way of getting rid of undesirable trees which are interfering with the growth of more valuable species. This system is practiced in India; in fact, judicious girdling and creeper cutting are there important cultural operations. The white ant soon takes care of all dead timber.

FIG. 1.—LARGE TABANUCO TREE.

Note the symmetry and smoothness of the trunk.

FIG. 2.—AN AUSUBO TREE IN THE OPEN.

FIG. 3.—GUM EXUDING FROM THE BRUISED ROOT OF A TABANUCO TREE.

Note the abundance of this gum in icicle-like formation. With a market for this gum the reserve could soon be made self-supporting.

WOOD STEALING.

As has already been mentioned, there is considerable depredation. Natives have stolen more or less wood from government land for many years. As good timber on private lands becomes scarcer, the public lands are gradually invaded. The amount stolen in a single year does not amount to much, but extended over many years it has been sufficient to make several valuable species scarce in all districts at all accessible.

These depredations are not nearly so great as is often represented. Persons near the reserve, anxious to get positions as rangers, have naturally exaggerated their amount. The truth is that very few natives have the outfits necessary to cut and handle the timber, and trails out of the woods are so few that any thieving is easily detected.

TRANSPORTATION FACILITIES.

The northwestern corner of the reserve is within 25 miles of the capital and 10 miles of Carolina, the terminus of the railroad. The writer has traveled from Juncos, the southwestern corner of the reserve, to the capital via Caguas and the military road by coach in three hours and thirty minutes. The same is possible by the road from Rio Grande, provided the rivers can be easily and quickly forded. In the neighborhood of the reserve there are several important cities—Rio Grande, Luquillo, Fajardo, Naguabo, Humacao, and Juncos. The most active and important of these is Fajardo, a port of considerable trade in sugar, hides, cocoanuts, etc. On the coast south of Fajardo and near to the village of Ceiba is one of the finest harbors in Porto Rico, which is wholly undeveloped. It is called the Ensenada Honda, and is landlocked, deep, and safe. No doubt some day a railroad will be built up the valley of the Loiza and its branch, the Gurabo, to this harbor and the city of Fajardo by the town of Naguabo. Timber could then be easily shipped by water to neighboring ports or islands or directly to the city of San Juan. If a large quantity of timber is never yielded by the reserve, the railroad would certainly be of great service in the shipment of charcoal and fuel wood. For water shipment Fajardo is at present the most convenient port. In the valley of the Loiza and its tributaries there is much fine sugar and pasture land. Cotton cultivation is beginning also on the eastern end of the island. Near at hand there is the island of Vieques, famous for its horses and cattle, and not far away Culebra Island, with a fine harbor, destined to become, in time, an important naval headquarters. From El Yunque the islands of St. Thomas, St. Croix, and others of the Virgin group are visible.

The railroad on the north ends at Carolina, and although the line has been surveyed and even leveled some distance farther eastward, bridg-

ing the Loiza and other obstacles prevented its further extension. When the railroads are completed (and this will come in time) the reserve ought to be in easy reach of the capital in less than a couple of hours. Then it will become a place of interest. As time goes on it becomes more and more difficult to preserve the wildernesses, where mountain and forest and stream are as nature made them. The process of clearing for scores of years in Porto Rico has driven the wilderness into the very fastnesses of the mountains.

No private owner could ever develop this region. The Government alone can afford to handle and properly care for it. For the Government to hold it without preventing depredation or improving it would be no better than private ownership. There should, however, be no objection to the use of the power in its many streams for lighting and transportation purposes, and to furnish power to the various sugar centrals and other business enterprises located in adjoining cities.

IMPORTANCE OF GOOD ROADS.

Nothing is of more importance to this country than roads. These must rank first of all needs, ahead even of educational institutions, since industry, communications, everything, in fact, is dependent upon them. This is truer of Porto Rico than of any other place known to the writer. Many good roads have been built, but unfortunately bridges are lacking. The value of many of the good macadam roads is vitiated by this lack. It seems strange to ride swiftly over a beautiful macadam and then suddenly stop for several hours on the bank of a stream to wait for the water to subside so that one can ford it. Bridges have been built in many instances, but many have been swept away in the awful floods which come from the deforested, impervious clay hillsides.

Anything but a good macadam is very nearly useless. The clay is so fine and tenacious that drainage is impossible. A dirt road soon becomes a mass of mud that resembles stiff yellow paint. No one can appreciate the character of these roads in rainy seasons without having had actual experience with them. The mountain trails are as bad if not worse. At times they are absolutely impassable for the traveler on horseback. In addition to deep holes filled with soft yellow mud and many streams to ford, there are places so steep and slippery that travel even afoot is well nigh impossible.

One never recovers from surprise at the toughness and ability of the little Porto Rican ponies to carry heavy loads over a trail where northern horses would break their legs and necks. It is not uncommon for them to drop on their haunches and actually slide down a steep embankment. The oxen also are fine beasts, very strong and large, and are indispensable in all forest work. It is said they are a cross between Spanish cows and Senegambian bulls.

The trails become so muddy at times that materials, such as provisions and coffee, are transported overland in canoes. These canoes are hollowed from tabanuco logs. They are flat on the bottom, with knobs cut at each end for attaching ropes or chains, and are dragged through the mud, uphill and down, by oxen, which stumble and fall and plunge, but manage somehow to get through. These fine beasts are goaded on in spite of holes and snags and mud. Sometimes their horns are actually twisted off by the yoke in a sudden turn or fall. They have the habit of stepping always in the same place, so that the trails are worn into corduroy-like ridges. Between the ridges there are pools of mud of unknown depth. A pony feels with care the depth of each hole, and when he withdraws his feet there is a loud suction. Travel, in consequence, even on horseback, is very slow and tiresome. Drainage, though especially needed in a country where it rains almost every day, is nearly impossible.

How to build trails or paths through these woods that would be lasting and fit for the snaking of timber is a problem that will be difficult to solve. This much, however, is certain—it will require constant attention to keep a dirt road in such shape that it will serve for the transport of timber.

There are practically no roads and no trails fit for transport within the reserve. Some of the trails in the cultivated districts are passable for a man on horseback during comparatively dry weather.

The trail from Rio Grande to Juncos up the valley of the Rio Grande and over the hills close to the reserve is impassable most of the time, and impassable at all times except for horses born and reared in this region. Most of the trails are impassable for persons afoot in consequence of the deep streams that must be forded. They have never been laid out with any attention whatever to topography. If there is a high hill the trail usually crosses over it instead of around it, and the descent seems to be usually in the steepest places. The Rio Grande trail is called even by the natives "El Camino Inferno." The trails up the Mameyes Valley to La Gloria, and up the Sabana Valley via La Perla and San Rosario, are also at times impassable for men on horseback. There are no other trails in the forested district of the reserve except an indistinct route to the top of El Yunque and a route over the mountains from La Gloria to La Florida. These are only dim footpaths, which one could easily lose without the services of a guide. Such are the highways and byways of this country. Although avenues of traffic, most of them are dangerous quagmires to all except those who are used to nothing better.

GOVERNMENT CONTROL NECESSARY.

The Luquillo district is fertile and tropical enough to grow almost all tropical products. There is also an abundance of fairly good labor.

It is greatly in need of roads, capital, and new industries. Money spent by the Government in the construction of roads and the improvement of the reserve would prove a wise expenditure. It would not flow back at once in a stream of profit, such as is usually expected by adventurers in the Tropics, but it would help to relieve to some extent a depressed condition, and it would serve as an object lesson to those who could do the same in a small way. The Government owns this land. Few private individuals have the inclination or the means to do otherwise than strip and despoil it. It would be improper to sell or lease it, and equally improper to do nothing toward its protection and improvement. As it stands to-day it is an unknown land, about which even those living near it tell tales of inland lakes, rich veins of gold, wild peoples, and other brain-born wonders. With a passable road across it it would soon become well known not only to the native but also to almost every tourist who comes to the island.

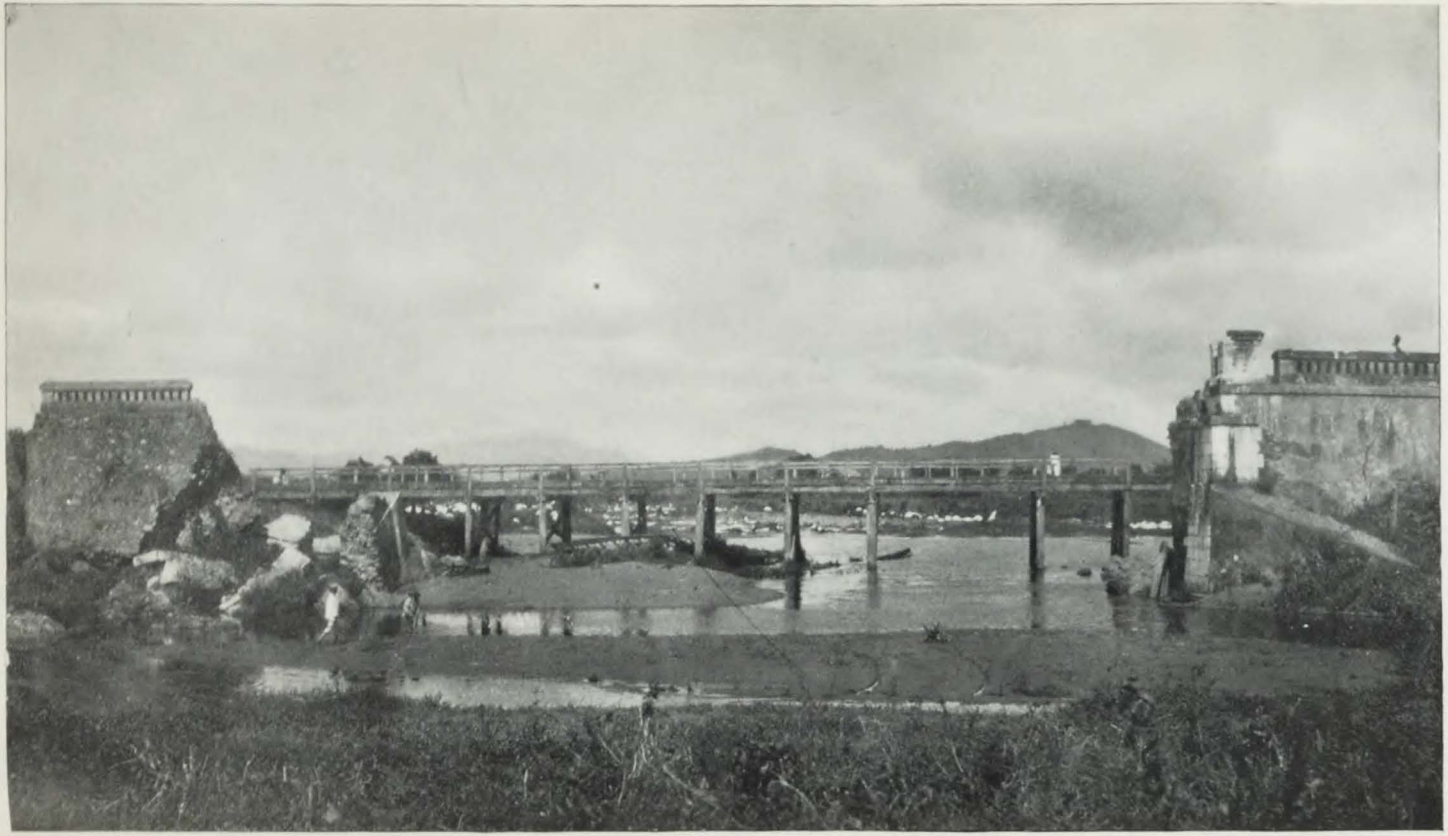
SUGGESTIONS IN REFERENCE TO THE ADMINISTRATION OF THE RESERVE.

SUITABLE HEADQUARTERS.

La Gloria, in the Mameyes Valley, is probably the best place for headquarters. It is centrally located and fairly accessible (see map). The trail which already exists could be improved and rendered passable for men on horseback. It is a place where labor could be easily secured. The water is pure and healthful, and there is good water power in case it is ever needed. It would be an excellent place for a meteorological station and for stocking the branches of the Mameyes with fish. Possibly several species of edible fish would live in the clear, pure pools of this river, especially in its upper parts. The water is well aerated, although the temperature was 76° in August. It would also be an excellent place for nurseries. It is well protected from the wind. It should be connected by telephone with Rio Grande westward through the reserve. Between Canovanas and Fajardo there is already a public telephone line.

THE WORK TO BE DONE.

The first year's work should be to establish headquarters, to survey the lines of private holdings, to study the species of trees and tree products of the region, to make topographical surveys, and to construct trails and telephone lines. To do this work the services of ten or a dozen natives would be required. Just as soon as roads could be constructed and improvement cuttings begun some income could be had from charcoal, timber, and gum. There would have to be an initial outlay for the construction of a house and the purchase of the necessary equipment. As time went on the reserve would become more and more nearly self-supporting; but it is doubtful if the area is large enough ever to yield sufficient timber to be wholly so. If, how-



PIERS REMAINING OF FINE MASONRY BRIDGE ON MILITARY ROAD WASHED AWAY BY FLOODS.

ever, it is made partly experimental, partly for soil protection and flood prevention, partly for a natural park to preserve a unique example of wild, tropical scenery, the Government expenditure would be fully justified. The Federal agricultural experiment station is located in the westernmost part of the island. The people of the east would be glad to profit by the establishment of a center of forestry in their midst. This would incidentally have an educational value.

In the neighborhood of the reserve there are considerable areas of land belonging to the insular government. Much of it is in small patches here and there, and a great deal of it is of little value from an agricultural standpoint. (Pl. II.) It seems that it would be wise for the insular government to place this land under the control of the officials in charge of the Federal reserve.

Just south of the reserve are two blocks of insular land containing 2,000 or more cuerdas of waste land called "terrenos baldios." On the east, in the neighborhood of Ensenada Honda, and on Vieques and Culebra islands there are large tracts worthy of being protected and improved.

RECOMMENDATIONS.

(1) That a field examination be made for the purpose of extending the present boundaries of the reserve to include the adjacent forest lands, especially those on the east, and for the purpose of excluding agricultural lands which are now within the boundaries.

(2) That a survey be made to establish permanent division lines between land belonging to the reserve and adjacent private holdings.

(3) That an arrangement be made with the insular government by which all lands within the limits of the reserve which fail to pay taxes shall revert to the Federal Government and become part of the reserve.

(4) That the reserve be protected and improved, as much for protective and scenic purposes as for the production of timber.

(5) That a road be built across the reserve to render it accessible to the public and to facilitate the transportation of forest products.

(6) That the insular government ask the cooperation of the Bureau of Forestry in the classification and administration of its forest and waste lands, especially of those in the eastern part of the island and on Vieques.

(7) That the Bureau cooperate with the Navy in the improvement of the island of Culebra, in case this island is used for naval purposes, by the planting of valuable trees for the protection of the water supply, for the checking of winds, and for the general improvement of the island.

(8) That game animals and fish be introduced into the reserve.

(9) That careful botanical and chemical investigations be made of the various minor products of the reserve district.

APPENDIX.

TREES OF THE LUQUILLO REGION.

By JOHN C. GIFFORD and O. W. BARRETT.[a]

MAGNOLIACEÆ.

Magnolia splendens Urban. "Laurel sabino" (Pl. VI, fig. 2).

First-class timber tree, 50 to 100 feet in height. Olive heartwood, changing after exposure to brownish. Fine-grained and aromatic. White, sweet-scented flowers, 2 to 3½ inches in diameter. Leaves with silvery pubescence underneath, although not always pubescent.

Next to ausubo this is probably the most valuable timber tree on the reserve. Used wherever it is not too scarce and expensive for construction work in the form of beams and boards. Valuable for cabinet work. Still found in patches in the more inaccessible parts of the reserve. Flowers, leaves, and fragrance similar to *Magnolia glauca* of the southern United States. With its light-colored trunk, silvery foliage, and fragrant, showy flowers this tree is worthy of cultivation for ornamental purposes. In the future treatment of the reserve, owing to the value of this wood in the local market, the growth of laurel sabino should be encouraged. It is probably called "laurel" because its leaves are used as a condiment, as is the famous laurel (*Laurus nobilis* L.) of southern Europe, and "sabino" because of the cedary aroma of its wood.

ANONACEÆ.

Anona muricata L. "Guanábena."

Cultivated and half-wild fruit, 10 to 35 feet high. Called "soursop" on English islands. Wood is soft and of little value.

Anona palustris L. "Cayul," "Alligator-apple," or "Corkwood."

Wood light, corky, and of little value.

Anona reticulata L. "Corazón."

Cultivated fruit tree, 15 to 30 feet high. Called "custard-apple" in English. Wood of little value.

Anona squamosa L. "Anone."

Cultivated fruit tree, 10 to 20 feet high. Called "sweetsop" in English. Wood of little value.

Oxandra laurifolia A. Rich. "Yaya blanca."

Twenty to 50 feet high. Hard wood of second class.

BIXACEÆ.

Bixa orellana L. "Achiote."

Light, soft wood. Reproduced from cuttings; 15 to 30 feet high. Arillus of seeds used for coloring. "Anatto" of commerce. Used for coloring soup, rice, butter, etc.

[a] Entomologist and Botanist of the Agricultural Experiment Station at Mayaguez, P. R.

Myroxylon [*Xylosma*] *schwaneckeanum* Krug & Urban. "Palo de candela," according to Cook.

Also called "palo colorado" and described as from 5 to 8 meters in height. This can not be the common "palo colorado" of the Luquillo. The common "redwood" or "palo colorado" is a monster, often reaching a diameter of 7 feet or more, although comparatively short in height (Pl. VI, fig. 1).

Casearia stipularis Vent. "Rabojunco."

Fifteen to 30 feet in height; wood second class, white and flexible.

EUPHORBIACEÆ.

Cicca disticha L. "Grosello."

Cultivated fruit, 15 to 30 feet in height. A pretty, but little-used wood. Reproduced from cuttings.

Jatropha curcas L. "Tártago."

Ten to 20 feet in height. Reproduced from cuttings. Used in live fences. Seeds medicinal.

Aleurites triloba Forst. "Nuez."

Twenty to 40 feet in height. Planted here and there. Not native. A favorite shade tree throughout the Tropics. Called "kukui-nuts" in Sandwich Islands; also "Indian walnut" or "candlenut." The nuts yield an oil valuable as drying oil for paints and varnishes.

Alchorneopsis portoricensis Urban. "Palo de gallina."

Twenty to 50 feet in height. Soft wood.

Hippomane mancinella L. "Manzanillo."

Fifteen to 50 feet in height. Poisonous. This is the common "manchineel" of southern Florida and the West Indies. According to Eggers it yields excellent timber, but is very little used on account of the caustic milky juice.

Hura crepitans L. "Molinillo."

Soft, wet wood. Used for live fences. Easily reproduced from cuttings. It attains a height of 30 to 60 feet.

Drypetes glauca Vahl. "Palo blanco," "Caféillo," "Varital."

Wood of inferior quality. Height 20 to 50 feet.

Drypetes alba Poit. "Caféillo."

Fifteen to 40 feet in height. Wood of inferior quality.

MALVACEÆ.

Paritium tiliaceum A. Juss. (*Hibiscus tiliaceus* L.) "Emmajagua."

A large shrub, 10 to 20 feet in height. Used for live fences. Bark extensively used for manufacture of native rope, baskets, etc. (See Pl. III, fig. 2.) One of the commonest, most beautiful, and useful plants in Porto Rico. Easily reproduced from cuttings; sprouts vigorously from the stump. Probably of value for paper manufacture. Bears an abundance of large, yellow flowers, and is highly ornamental.

Thespesia populnea Soland. in Corr. "Majuquilla," "Palo de jaqueca."

A very beautiful, erect tree, with symmetrical crown and showy flowers. It yields a valuable fiber for rope. Easily reproduced from cuttings; useful for live fences and for shade along avenues. It grows in wet ground. Wood hard and durable.

Thespesia grandiflora DC. "Maga."

Rare in the Luquillo region. A thick foliaged, very beautiful ornamental shade tree with large, pendant, reddish flowers. Yields a first-class, fine, hard, olive-brown timber. Its height varies from 30 to 60 feet.

The three species just named of the order Malvaceæ are worthy of extensive and systematic culture. They are all quick growing, easily propagated, and extremely ornamental and useful.

BOMBACACEÆ.

Eriodendron anfractuosum DC. "Ceiba."

A very large and common tree. Wood of inferior quality; soft and white. Extensively used in the manufacture of large dugouts in parts of the West Indies; in fact, the word "ceiba" is said to be the old Caribbean word for "boat." The wool on the seeds is used in some places for stuffing mattresses and pillows, but in Porto Rico material for this purpose is collected from the seed pods of *Ochroma lagopus*. This wool, which is commercially known as "kapok," is extensively shipped to the United States from the East. According to various reports, this industry is very remunerative in Java, where labor is cheap and plentiful and the tree has been extensively planted. This would probably prove an excellent industry for Porto Rico if properly exploited.

Ochroma lagopus Sw. "Goano" or "Corkwood."

One of the commonest trees in Porto Rico. Said to be the lightest of all woods, with a specific gravity of 0.120. Down used for stuffing pillows, bark for making rope, and the wood in place of cork for floating nets, etc.

STERCULIACEÆ.

Guazuma ulmifolia Lam. "Guásima."

Twenty-five to 50 feet in height. Wood light and of inferior quality.

TILIACEÆ.

Sloanea berteriana Choisy. "Cacao motilla," "Cacao roseta," "Motilla."

White wood of second class; 25 to 80 feet in height.

CLUSIACEÆ.

Clusia sp. "Cupey."

Hard wood. Used for posts.

Mammea americana L. "Mamey."

English "Mammee." Cultivated and wild, 25 to 50 feet in height. It bears fruit and produces medicinal gum. The wood is red in color, heavy, and durable.

SAPINDACEÆ.

Cupania americana L. "Guara blanca."

Rare in Luquillo district; 20 to 50 feet in height. Wood second class; used for posts, etc.

MELIACEÆ.

Melia azedarach L. (*Melia sempervirens* Sw.) "Alelaila."

Ornamental, rapid growing tree, 20 to 50 feet in height. Umbrella variety; introduced from United States for shade.

Swietenia mahagoni L. "Mahogany," "Spanish caoba."

Conspicuous by its apparent total absence. Not a single specimen seen on the reserve, and only one or two reported for the whole island. Reported from Vieques Island not far to the eastward. What might lead one to think that mahogany once existed in Porto Rico is the fact that the word occurs in the names of places. For instance, there is the "Mangler Caoba Laguna Soroco y Grande" on the eastern end of the island. According to Eggers mahogany is not uncommon in wooded valleys and

along roads and around dwellings in St. Croix and St. Thomas. It is also common in Santo Domingo. Its total absence is therefore strange. If it ever did exist in Porto Rico to any extent, and it seems more than likely that it did, its extermination has been singularly complete. One would expect to find it in the rich, protected valleys of the Sierra Luquillo above all others, especially in those places which are practically inaccessible. In this apparently untouched, uninhabited virgin wilderness much more has happened in the past than appears at first sight. High up on the slopes of El Yunque, for instance, there is still left the mark of a trocha built by a Spanish general. (This bridle path was built under the orders of Juan de la Pezuela, governor of Porto Rico from 1848 to 1851.) Generally in this land of rapid growth man's interferences are soon overgrown and obscured. I have no doubt that mahogany once existed in these mountains in more or less abundance, and that the trees were cut and converted into boards on the spot and then transported to the trails and roads on the backs of men, as is still the custom with other species.

Cedrela odorata L. "Cedro hembra."

The famous West Indian cigar-box cedar is also practically on the verge of extinction in this district. It is now so rare that one may travel for days in the forest without seeing a single specimen. The writer saw one tree on the edge of the reserve which the owner was trying to sell on the stump. No purchaser could be found because of its almost inaccessible location. This alone has saved it all these years.

Guarea trichilioides L. "Guaraguao."

First-class wood, fine grain, reddish-brown heart, 30 to 80 feet in height; fragrant at first. One of the four most important woods on the reserve. It closely resembles and is apparently as good as *Cedrela odorata*. The wood of *Cedrela toona* of the East Indies is used in the manufacture of furniture, which is sold under the trade name of "toona mahogany." No doubt "guaraguao" might be used in the same way. It lacks, however, sufficient aroma to render it fit for cigar boxes. It makes good boards, and is extensively used in cabinet work. The better grades of it might even pass for mahogany. The name "guaraguao" is applied also to a native hawk and to a rocky peak which one passes on the way to the top of El Yunque from Santa Catalina. It is probably an old Indian word.

——— ——— "Guara."

A wood of inferior quality, soft and white, 40 to 100 feet in height.

RUTACEÆ.

Citrus spp.

Cultivated fruits.

Xanthoxylon clava-herculis L. "Espino."

Thirty to 80 feet in height. Of inferior quality.

AQUIFOLIACEÆ.

Ilex sp. "Cuero de sapo."

Second-class hardwood, 30 to 60 feet in height.

Ilex sideroxyloides Griseb. "Gongolin," or "Central American oak."

Second-class flesh-colored wood, 30 to 50 feet in height.

Ilex nitida Maxim. "Hueso prieto."

Second-class wood.

——— ——— "Rabojunco."

Ten to 20 feet in height; used for poles.

URTICACEÆ.

Ficus lentiginosa Vahl. "Jaguey."

Third-class striped, flesh-colored wood. Semiepiphytic at first. Destroys trees.

Ficus spp. "Higuero."

Soft-wooded trees.

Cecropia peltata L. "Yagrumo hembra."

Twenty to 60 feet in height. Big-leafed, striking tree when the wind turns its silvery foliage to view. The trunk is hollow and the wood light. From it the natives make carrying poles.

POLYGONACEÆ.

Coccoloba rugosa Desf. "Ortegon."

Rare. Purplish heartwood; 40 to 100 feet in height. Hard, heavy, first-class wood. Other species of Coccoloba or Coccolobis are common on the seacoast not far from the reserve.

BALSAMEACEÆ.

Bursera gummifera L. "Almácigo."

Grows from cuttings; 20 to 40 feet in height. Wood of little value. Used for live fences.

Dacryodes hexandra Griseb. "Tabanuco" (Pl. IV, fig. 2, and Pl. VII).

One of the four most-used timbers of Porto Rico. From straightness of bole, freedom from lower limbs, and very gradual taper, one of the finest, if not the finest, tree for logging in Porto Rico. Trees 5 feet in diameter, rising to a height of 50 feet without a limb, are not uncommon. No extensive buttresses to prevent close cutting. Clean, smooth bark. Although it does not coppice, it grows in close stand and reproduces from seed easily and naturally. Grows in patches or groups of almost pure stand. Abundant on eastern side of reserve. More timber of this species than of any other, and over considerable areas more timber of this species than of all other kinds together. Wood is of medium hardness and weight. It is somewhat cross-grained, and brownish in color. Not durable when exposed to weather. Used for floor boards, ceiling stuff, etc. One large lumber dealer in New York places it in the same class commercially with yellow poplar, and agrees to handle it on exactly the same terms if supplied in sufficient quantity. It is, however, much handsomer grained than yellow poplar, and is susceptible of a much finer polish. The fact that this tree grows well in close, pure stand is a great advantage in a tropical country, where the mixture is usually of an almost hopeless character from both forestry and lumbering standpoints. This great mixture requires a correspondingly great variety of machinery, and there is produced a small quantity of many kinds of lumber of all grades and values. In many parts of the reserve it would not be difficult to create in a short time large areas of pure tabanuco. On one-quarter acre the writer counted 20 tabanuco trees over 6 inches in diameter. The largest had a diameter of 5 feet. In addition there were 75 tabanuco saplings. On another sample area in the tabanuco district of one-quarter of an acre there were 8 tabanuco trees over 6 inches and 100 seedlings and saplings. On another quarter of an acre there were 26 tabanuco trees over 6 inches and under 2 feet in diameter, and a large number of seedlings. In short, it is the predominating tree of the eastern part of the reserve.

In addition to timber this tree yields an immense amount of gum. If the bark is carelessly hacked, there exudes all over its trunk an immense quantity of this material. The method of tapping is similar to that used in Central America for the collection of rubber. Many slanting cuts are made in the trunk with the machete. This gum contains a volatile turpentine which on evaporating leaves behind a rosin which is extensively used by the natives for candles and torches. If a profitable

use could be found for this material enormous quantities could be easily and cheaply collected. A tree will yield a large quantity without apparent injury. A revenue from this gum might in time render the reserve financially self-supporting. It is asserted to be of value for medicine, varnish, soap, etc.; but a series of experiments is necessary in order to determine its real value.

Closely related to tabanuco are several gum-yielding trees, the value of which is not known, such as *Amyris balsamifera*, *A. elemifera*, *A. maritima*, and *A. sylvatica*. These are known by the name of "téa." The gum of *Amyris linaloe* of Mexico yields a base for perfumes. It is shipped in considerable quantities to Europe and to some extent to New York.

Over a million dollars' worth of chicle, the gum of the Mexican tree, *Acras sapote*, is annually sent to the United States from Mexico for chewing gum. Perhaps some of the gums of the tabanuco type might be used in the same way.

Spondias lutea L. "Jobo."

One of the commonest trees in Porto Rico. Everywhere along the roadside. Used for live fences. Easily reproduced from cuttings. Coppice.

Spondias purpurea L. "Ciruela," or "Spanish plum."

Cultivated fruit.

Mangifera indica L. "Mangó."

Familiar fruit, the apple of the Tropics. Wood used for charcoal. Coppice. Wood is underrated in the West Indies. In India used for tea boxes, window frames, etc., and may be stained to imitate toon or cedar.

Anacardium occidentale L. "Pajuil."

Cultivated and wild fruit. Commonly called "Cashew."

Hedwigia balsamifera Sw. "Masa."

A resinous forest tree with fragrant rose or yellowish wood of superior quality, 20 to 50 feet in height. A little-known tree worthy of careful study from a commercial standpoint. In Guatemala it is called "copal."

FABACEÆ.

The trees of this order are of much more importance from a cultural than a timber standpoint, especially to the coffee growers of Porto Rico. These trees are not only a protection against the wind and a fixer of the soil in rough mountain regions, but also conservers of nitrogen. Under the influence of their humus and shade the soil is kept in fertile condition without the use of artificial fertilizers.

Agati grandiflora Desv. "Gallito."

Used for poles. Rapid growing. Ten to 30 feet in height.

Erythrina spp. "Bocáre."

Coffee and cacao nurse tree. Produced from cuttings.

Andira inermis H. B. & K. "Moca."

Porous wood. Twenty to 60 feet in height. Common forest tree, but rarely used for coffee shade.

Tamarindus indica L. "Tamarindo."

Cultivated and wild fruit. Wood light yellow. No heart. Twenty to 60 feet in height.

Hymenæa courbaril L. "Algarrobo."

West Indian locust. First-class, heavy wood, with reddish heart; 40 to 80 feet in height. Produced from cuttings. Coppice.

Inga laurina Willd. "Guamá."

Coffee shade, 20 to 50 feet in height. Coppice.

Inga vera Willd. "Guava."

Best coffee shade, 20 to 50 feet in height. Coppice.

Ormosia dasycarpa Jacks. and *O. krugii* Urban. "Palo de matos," "Mato."
Inferior wood; 30 to 100 feet in height. Used for charcoal. Seeds red and black, and very hard.

Poinciana regia Boj. "Flamboyan."
Beautiful shade tree, common throughout the West Indies.

Pithecoloium saman Benth. "Saman," "Guango."
Excellent for shading nutmegs, cacao, tea, coffee, and pastures. Beans fed to cattle.

Albizzia lebbek Benth. "Acacia amarilla."
Beautiful shade tree.

CHRYSOBALANACEÆ.

Hirtella sp. "Teta de burra."
Hard, heavy wood; 20 to 50 feet in height.

MYRTACEÆ.

Myrcia splendens DC. and *M. berberis* DC. "Rama menuda."
Second-class timber; 15 to 30 feet in height.

Myrcia spp. (*Eugenia* spp.) "Hoja menuda."
Second-class wood; 20 to 60 feet in height.

Myrcia spp. "Guayabacon."
First-class, very hard, heavy wood, with red heart. *Myrcia acris* DC. of neighboring islands supposed to yield bay rum of commerce. The Porto Rican bay-rum tree is *Amomis caryophyllata* Krug & Urb.

Jambosa vulgaris DC. "Poma rosa," "rose apple."
Extensively planted for barrel hoops, poles, and fuel wood. Coppice. It attains a height of 15 to 50 feet. Native of East Indies, but naturalized in Porto Rico.

Pimenta (?). "Pimenta cimarron."
First-class hard, reddish wood. It grows 30 to 60 feet in height. The true allspice of Jamaica probably does not grow in Porto Rico. This pimenta is probably the bay-rum tree *Amomis caryophyllata* Krug et Urb.

Psidium guajava L. "Guayava."
Produces best charcoal and first-class posts. The wood is hard and heavy. Its height is 10 to 30 feet. Valuable fruit guava.

Punica granatum L. "Granado," "Pomegranate."
Cultivated fruit.

Calyptranthes sintenisii Kiaersk. "Limoncillo."
First-class wood; rare; hard, flexible.

Eugenia stahlii Krug & Urb. (?) "Guayabota."

Eugenia spp. and *Myrcia* spp. "Cieneguillo."
Second-class woods, poles, etc.; very hard, reddish.

MELASTOMACEÆ.

Tamonea spp. "Camacey," "Camacey blanco," "Camacey paloma," "Camacey canales," "Camacey bobo."
About five species occur, which are used for poles and charcoal. Nearly all coppice freely.

COMBRETACEÆ.

Terminalia catappa L. "Almendro."
Third-class wood, light and coarse. Favorite shade tree. Thirty to 60 feet in height.

Bucida capitata Vahl. "Granadillo."

This is a common tree in the eastern part of the reserve. It is the "yellow sanders" of the British West Indies. First-class, fine-grained, yellow, satiny timber. It ranges from 50 to 100 feet in height. Coppices freely.

Bucida buceras L. "Úcar blanco."

First-class, hard, white wood, called "wild olive" in Jamaica.

LAURACEÆ.

Persea gratissima Gaert. "Aguacate."

The famous "avocado pear," cultivated and wild, wood soft.

——— ——— "Aguacatillo."

Soft wood. Height 30 to 60 feet.

Nectandra sp. "Nuezmoscado."

Porto Rican nutmeg (not true nutmeg); 40 to 100 feet in height. Good timber. Aromatic lumber, with brownish heart.

FLACOURTIACEÆ.

Homalium racemosum Jacq. "Guajanilla" (?), "Caracolilla."

Thirty to 60 feet in height. Timber good, strong.

ARALIACEÆ.

Didymopanax morototoni Decne. & Planch. "Yagrumo macho."

Inferior wood; heart olive brown, light. Its height is 30 to 60 feet.

RUBIACEÆ.

Genipa americana L. "Jagua."

Thirty to 60 feet in height. Second-class, creamy sapwood. Brownish heart, fine grained. Edible fruit. Coppice.

Guettarda sp. "Cucubano."

Ten to 40 feet in height. Second class.

Faramea odoratissima DC. "Palo de toro."

Ten to 30 feet in height. Hard, heavy. Used for poles.

Rondeletia portoricensis Krug & Urb. (?)

Coffea arabica L. "Café."

Antirrhœa obtusifolia Urban. "Tortuguillo."

Small, rare tree.

Antirrhœa coriacea Urban. "Boje quina."

Second-class, yellow, brittle wood.

SAPOTACEÆ.

Chrysophyllum cainito L. "Cainito."

Twenty to 50 feet in height. Cultivated and wild. Hard, reddish wood.

Chrysophyllum glabrum Jacq. "Lechecillo."

Chrysophyllum monopyrenum Sw. (*C. oliviforme* Lam.) "Lechecillo."

Twenty to 50 feet in height. Hard, first-class wood.

——— ——— "Caimitillo."

Thirty to 60 feet in height. Hard, first-class wood.

Sideroxylon mastichodendron Jacq. "Ausubo" (Pl. V, fig. 2, and Pl. VI, fig. 3).

Called "mastic" in southern Florida. A valuable West Indian timber tree. Probably the most valuable wood per cubic foot in Porto Rico that is used for ordinary construction purposes. Large heart, maroon red, very hard, heavy, straight-

grained, durable, and strong. Of great value for beams and rafters. Its height is 50 to 100 feet; the diameter 2 to 5 feet. Fruit edible. Old stumps do not coppice. Possibly two species are included under this name. Each year the natives go farther into the mountains in search of it, and often cut it on Government land. The use of this timber is limited by its great cost, although it is in great demand for supports to heavy tile roofs and beams for floors and miradors. One dealer in the central part of the island asked $16 apiece for timbers 16 feet long and 4 by 6 inches. This is no safe criterion, however, since even timber has no fixed price. The price varies with the locality, and in some places it is difficult to get this wood at any reasonable figure.

Lucuma multiflora A. DC. "Jácana."
Forty to 80 feet in height. First-class, hard, tough, light-colored wood.

OLEACEÆ.

Mayepea domingensis (Lam.) Krug & Urb. "Hueso blanco," "Palo de hueso."
Second-class, hard, white wood.

Mayepea caribbæa Kuntze, "Avispillo."
Light, inferior wood.

BIGNONIACEÆ.

Crescentia cujete L. "Higüera," "Calabash."
Cultivated and wild. Fruit shell used for utensils. Height, 10 to 30 feet. Wood very tough. Charcoal. Coppice.

Tecoma pentaphylla DC. "Roble blanco."
Second-class strong wood, used for ox yokes, etc. Height, 20 to 50 feet.

STYRACACEÆ.

Styrax portoricensis Krug & Urb.

Symplocos martinicensis Jacq. "Aceituna blanca."
Second-class, hard, white wood. Height, 10 to 30 feet.

Symplocos polyantha Krug & Urb. and *S. micrantha* Krug & Urb. "Palo de cabra."
Inferior woods, light, soft. Height, 20 to 60 feet.

BORAGINACEÆ.

Cordia alba Roem. & Schult. "Capá blanca."
Rare, first-class wood. Height, 50 to 80 feet. Heavy, fine-grained, heart large, olive brown. Used for rice and coffee mortars, etc. Coppice.

Cordia macrophylla L. "Moral."
Third-class, light, soft wood. Charcoal, posts, etc. Height, 25 to 50 feet.

Cordia borinquensis Urban. "Muñeca."
Second-class wood; fine grain. Height, 25 to 50 feet.

VERBENACEÆ.

Vitex divaricata Sw. "Higuerillo," "Péndulo blanco."
First-class, strong, white wood. Height, 30 to 60 feet. Coppice.

Citharexylum quadrangular Jacq. "Péndulo colorado."
First-class, strong, yellowish or reddish wood. Height, 20 to 50 feet. One of the fiddle-woods. This use gave rise to the generic name "Citharexylum."

PHOENICACEÆ.

Acrista monticola Cook, "Palma de la sierra," "Yagua del monte."

Trunk "shell" split into boards for huts. Leaves used for thatching roofs (see Pl. I.)

Roystonea borinquena Cook. "Porto Rican royal palm," "Yagua."

Trunk used for same purpose as that of *Acrista monticola*. Leaf sheaf used for thatching roofs and sides of houses (Pl. III, fig. 3.) Also for washtubs and similar uses. Berries fed to hogs.

Cocos nucifera L. "Cocoanut."

Grows in the hills well within the limits of the reserve. There appear to be two kinds of cocoanuts in Porto Rico, one with brown and the other with green colored nuts.

Inodes cauziarum Cook. "Porto Rican hat palm" or "yaray."

The famous Porto Rican hat palm; does not grow on the eastern end of the island.

POACEÆ.

Of this order, bamboo, or *Bambusa vulgaris* Schrad., is common.

FILICES.

The most striking representative of this order is the tree fern, *Cyathea arborea*, which, although of no commercial value, is a plant of great beauty.

ADDENDA.

Sabiaceæ.

Meliosma herbertii Rolfe and *M. obtusifolia* Krug & Urb. "Aguacatillo."

Inferior, light wood. Height, 20 to 50 feet.

Myrsinaceæ.

Ardisia spp. "Mameyuelo."

Second-class, white, hard wood. Furniture. Height, 20 to 50 feet.

Canellaceæ.

Cinnamodendron macranthum Baill. "Chupogallo" ("Caro" ?).

Second-class, hard, white wood.

Thymelaeaceæ.

Daphnopsis philippiana Krug & Urb. "Emmajagua brava."

Height, 8 to 25 feet. Bark used in making rope. These "asogas" have a disagreeable taste, which prevents their being bitten off by tethered animals.

Malpighiaceæ.

Byrsonima spicata. "Maricao."

Wood pinkish or purplish, heavy, hard, first-class. Height, 20 to 50 feet.

——— ——— "Guajona."

Large tree, 50 to 100 feet in height. Second-class wood. Used for boards. Heart reddish, fine grain.

——— ——— "Guajanillo."

First-class wood. Height, 30 to 80 feet. Strong, reddish yellow. Used for beams.

Simaroubaceæ.

Picramnia pentandra Sw. "Guarema."
Wood dark, heavy, hard.

Simarouba tulæ Urb. "Aceitillo."
Height, 20 to 50 feet. Rare.

Hernandiaceæ.

Hernandia sonora L. "Mago."
Wood light, cream-colored, fine-grained. Height, 30 to 60 feet. A rare and peculiar tree; found also in the East Indies.

Rutaceæ.

Ravenia urbani Engl. "Tortugo prieto."
Rare. Height, 30 to 50 feet.

Apocynaceæ.

Tabernæmontana citrifolia L. "Pegoge."
Small tree.

Theaceæ.

Ternstræmia luquillensis Krug & Urb. "Palo colorado."
Crooked, gnarled tree with red bark. It attains a height of 30 to 60 feet and diameter of 3 to 8 feet. Little used, but common in places on the reserve. The natives pronounced this wood of little value, although I was told a wood called "colorado" is sometimes sold for "ausubo."
Ternstræmia pachyphylla Krug & Urb. and *T. heptasepala* Krug & Urb. are smaller trees than the above.

TREES WHICH OCCUR IN OR NEAR THE LUQUILLO FOREST RESERVE, ACCORDING TO VARIOUS REPORTS.

The following is mainly a collection of local common names of trees which probably occur in or near The Luquillo Reserve.

Abejuelo, quitaran, *Colubrina ferruginosa* Brongn.
Aceituna macho.
Aceitunillo.
Almendron, almendrillo, *Prunus occidentalis* Sw.
Arrejan, palo colorado (?), *Prioria copaifera* Griseb. (?).
Azafran, laurel puero.
Bariaco.
Boniato.
Brazil.
Cabode hacha, *Trichilia diversifolia* A. Juss., *T. pallida* Sw.
Cacao cimarron.
Cacao de monte, cacao macho (?).
Canelilla.
Canelo (2 varieties).
Canelon.
Capa prieta, *Cordia gerascanthus* L., *C. gerascanthoides* H. B. & K.
Capacillo, capaillo.
Caro, chino.
Cedro macho.
Ceibilla.
Cenizo, *Fagara martinicensis* Lam., *Tetrazygia elæagnoides* (Sw.) DC.
Cipil, pino.
Cobana negra, *Stahlia maritima* Bello. A valuable black wood of the seashore. Very durable. Resembles ebony.
Cocarron, *Elæodendron xylocarpum* DC.
Cojoba blanca.
Corcho blanco.
Corcho negro.
Cotona.
Cotorra.
Cucuracey.
Cupeillo, *Clusia krugiana* Urban and *C. acuminata* Spreng. (*Rheedia portoricensis* Urb.)
Enernaseada.
Enrubio.
Espejuelo amarillo, espejuelo bobo.
Espinillo.
Espino amarillo, Espino blanco, Espino rubial, *Fagara pterota* L., *F. caribæa* Kr. & Urb.

Gaita, *Hypelate paniculata* (?). Cambess.
Garrocho.
Gateado, *Piratinera guianensis* Aubl. (*Brosimum guianensis* ?).
Gen gen.
Geo geo.
Guabara.
Guajona.
Guanabanillo.
Guanaguao.
Guansa.
Guasa.
Guasabara, *Eugenia tetrasperma* Bello, *E. æruginea* DC., *E. eggersii* Kiaersk.
Guasabarillo.
Guasimilla.
Guayabota roja.
Guayacan, *Guajacum officinale* L. Well-known "lignum vitæ." Coast tree. Now scarce.
Hucarillo.
Huso amarillo, *Huso blanco.*
Huso colorado.
Jaboncillo, *Sapindus* sp. (?).
Jaya.
Laurel blanco, Laurel prieto, Laurel puero.
Leche prieta, *Chrysophyllum* sp. (?).
Mabi, *Colubrina* sp. (?)
Malta de mata, Malta arborea.
Mangle bobo.
Matillo.
Moca acatera, Moca amarillo, Moca negra (?).
Murta, *Eugenia* sp.
Naranjillo.
Negra lora, *Maba inconstans* Griseb.
Palo de aceite, *Copaifera officinalis* L.
Palo bobo, *Pisonia subcordata* Sw.
Palo cano.
Palo de galleria.
Palo de garrocha, *Quararibea turbinata* Poir.
Palo puerco.
Palo punz, palo santo.
Pendejuelo.
Pimienjo.
Rabo puedo.
Ramonillo, ramoncillo (?).
Retamo.
Retan.
Rubial.
Seboruquillo, *Thouinia striata* Rdalk., *T. tomentosa* Bello.
Serra suela, *Thouinia portoricensis* Radlk.
Tabacon.
Tabloncillo, *Dipholis montana* Griseb.
Tachulo blanco.
Tantillo, *Randia aculeata* L.
Teta de curra.
Toro.
Tortugo, Tortugo blanco, Tortugo amarillo.
Tortuguillo amarillo, Tortuquillo blanco (?).
Yaiti (?).
Zaiti (?).
Zaiti negro (?).
Zaya (?).

There are no doubt many more species which grow in the neighborhood of the reserve which are slightly, if at all, known. The above list is sufficient to show the great variety of trees of eastern Porto Rico, and that it is one of the most fertile fields for botanical research. There is work enough of this kind to keep a botanical commission busy for more than a single year. The botanical names of many important trees are not known or are uncertain, not to mention their silvicultural peculiarities and usefulness for forest purposes. Much of the information in print in reference to the trees of this region comes either directly or indirectly from the native, who is seldom particular about the accuracy of his statements. When one adds to the jungle of scientific names the fact that a single species may have a dozen common names within a radius of a few miles, the situation becomes perplexing, to say the least. Add to this the fact that botanists are naming new species on slim bases and constantly changing the nomenclature for slight reasons, and the almost hopelesss plight of the forester who is after important silvicultural and commercial information in reference to useful timber trees may be imagined. That these tropical trees bloom at irregular times, and not in one season as in the North, and the further fact that trees in the dense forest seem to flower seldom, and that when they do the flowers are few in number and out of reach, adds to the difficulty in determining species.

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